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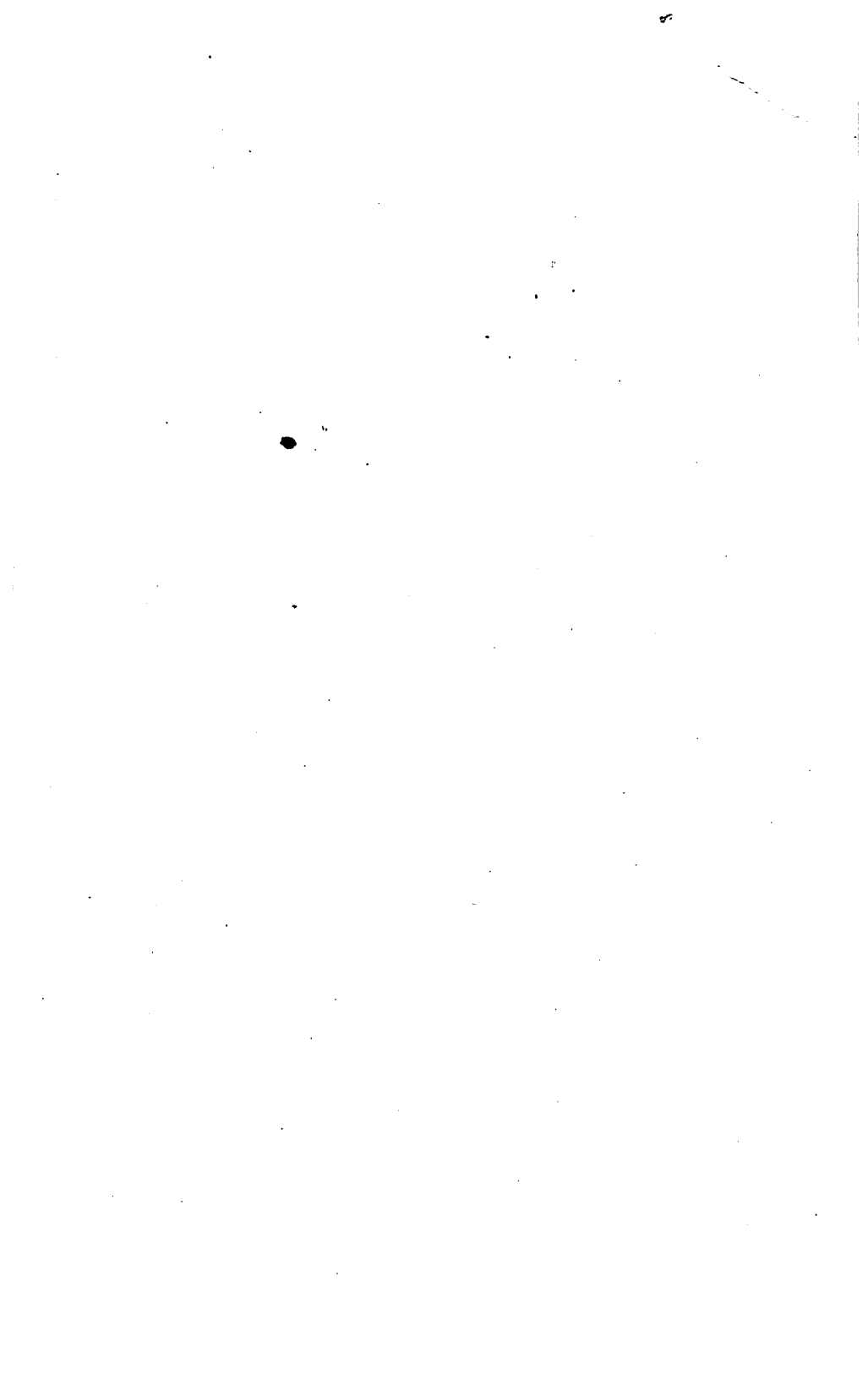
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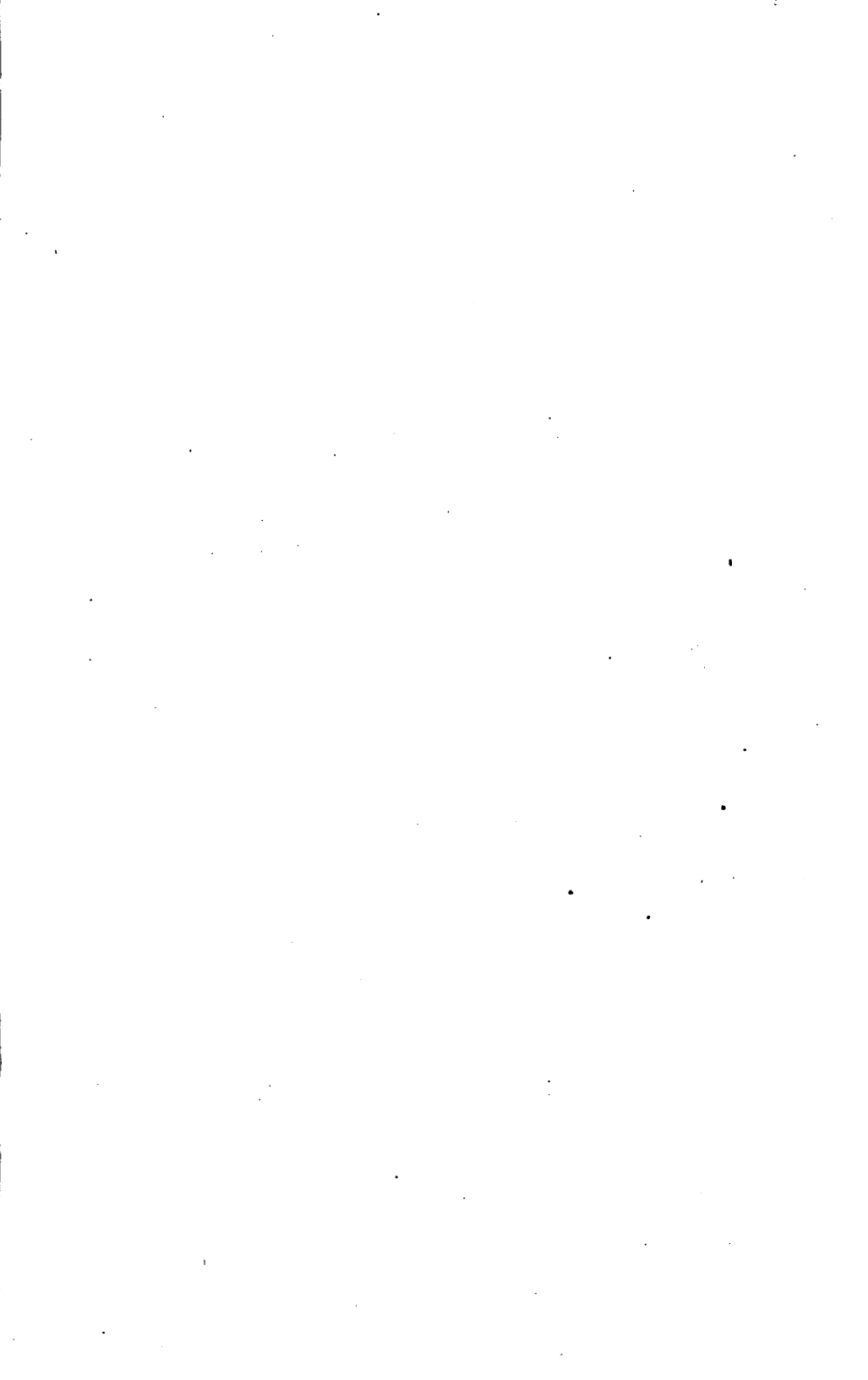
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STATE OF VERMONT.

SIXTH

ANNUAL REPORT

—OF THE—

STATE AGRICULTURAL

EXPERIMENT STATION.

1892.

BURLINGTON:
FREE PRESS ASSOCIATION, Printers and Binders.
1893.

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Book I

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FINANCIAL REPORT

FOR THE FISCAL YEAR ENDING JUNE 30, 1892.

The State Agricultural Experiment Station

OF VERMONT

In Account with the United States.

DR.		
To appropriation.....		\$15,000 00
CR.		
By Salaries.....	\$4,084 95	
“ Labor.....	3,677 96	
“ Buildings.....	568 09	
“ Water, gas, fuel and telephone.....	1,118 17	
“ Library.....	4 50	
“ Apparatus.....	462 86	
“ Chemicals.....	184 59	
“ Horticultural supplies.....	90 19	
“ Vehicles and team equipments.....	181 03	
“ Tools and farm implements.....	170 58	
“ Stationery, postage and telegrams.....	175 63	
“ Printing.....	1,426 18	
“ Live stock.....	22 50	
“ Traveling expenses.....	947 92	
“ Furniture.....	87 15	
“ Freight, cartage and express.....	233 77	
“ Incidentals.....	184 97	
“ Supplies.....	1,689 46	
		\$15,000 00

We, the undersigned, duly appointed auditors for the corporation, do hereby certify that we have examined the books and accounts of the Experiment Station of the University of Vermont and State Agricultural College, for the fiscal year ending June 30, 1892; that we have found the same well kept, and correctly classified as above, and that the receipts for the time named are shown to have been \$15,000.00, and the corresponding disbursements \$15,000.00, for all of which proper vouchers are on file, and have been by us examined and found correct.

M. H. BUCKHAM,
CASSIUS PECK,
G. S. FASSETT,

Auditing Committee of the Board of Trustees.

I hereby certify that the foregoing statement of account, to which this is attached, is a true statement from the books of account of the institution named

E. HENRY POWELL,

{ SEAL. }

Treasurer.

We, the undersigned, do hereby certify that the above is the signature of E. Henry Powell, treasurer of the University of Vermont and State Agricultural College, and that the above is the seal of said institution.

W. W. COOKE,
Director Experiment Station.

G. G. BENEDICT,
*Secretary University of Vermont
and State Agricultural College.*

REPORT OF THE DIRECTOR.

The present report covers the work of the Station from January 1 to December 31, 1892, though a part of the work in the test of corn fodder and ensilage extended into the year 1893. The financial report covers the year ending June 30, 1892.

PUBLICATIONS.

During the year four bulletins have been issued, as follows :

January. No. 27. Tests of Dairy Apparatus.

April. No. 28. Plant Diseases :

1. Potato Blight and Rot.
2. A New Potato Disease.
3. Potato Scab.
4. Apple and Pear Scab.
5. Oat Smut.

May. No. 29. Analyses of Licensed Fertilizers.

June. No. 30. The Results of the Bounty on Maple Sugar.

CHANGES IN STATION STAFF AND EQUIPMENT.

Few changes have taken place in the working force during the year. Mr. C. W. Minott resigned his position as Horticulturist of the Station, Mr. D. D. Howe, of Brookfield, Vt., has become the Farm Superintendent, and Mr. E. H. Powell the Treasurer of the Station. During 1892 the equipment of the Station was increased by the addition of 30 acres to the farm for a pasture. It also became necessary to build an addition to the creamery to accommodate the students of the Dairy School.

THE WORK OF THE YEAR.

There has been no notable change in the character of the work the past year from that of previous years. Most of the lines of investigation can be grouped under the headings, Fertilizer Control, Pig Feeding, Plant Diseases and their Remedies, and Dairying in the broadest sense of this latter term. The results obtained in these several lines will be very briefly sketched in the following report.

FERTILIZER CONTROL.

As required by law, this Station has made analyses during the year of the various brands licensed for sale in this State. The results have shown

that the farmer has obtained plant food in the fertilizers at about the same price as during the previous year. All of the fertilizers have been up to their guarantees.

A comparison has been instituted between the results of the fertilizer inspection in Vermont for the years 1885 to 1893 inclusive. Some very interesting facts are brought to light. The retail price of fertilizers has dropped steadily during these nine years from \$37.90 in 1885, to \$32.32 in 1893, or a fall of \$5.58. At the same time the composition of the fertilizers has somewhat improved. There was a decided improvement during the years 1888 and 1889, since which there has been a falling off in quality, but the average goods in 1893 are worth about \$1.50 a ton more than the goods of 1885. It is evident then, that the farmer at the present time is getting more plant food for his money than he was eight years ago. A dollar in 1893 bought as much plant food as \$1.24 in 1885. On the aggregate fertilizer business of the State this amounts to a large sum. It means that the farmers of this State are saving \$50,000.00 yearly from what the same fertilizers would have cost in 1885. Many influences have combined to produce this result, and there is no doubt but that the work of the Station in sampling, analyzing and publishing the results broadcast over the State has been one of these influences, and by no means the least.

PIG FEEDING.

The work in pig feeding during the past year has been a continuation of that of previous years, the general idea being to ascertain the best and most economical way of using the skimmilk from the dairy for the production of pork. The experiments conducted seem to show that sour skimmilk produced just as good results pound for pound as sweet skimmilk. Where there was any difference it was in favor of sour skimmilk. This corresponds with the results obtained in a similar investigation a year ago, and seems to indicate that farmers need not be afraid that they are losing money every time the milk sours on the way home from the creamery, and creamery men need not go to any expense or trouble to so handle the skimmilk as to sterilize it and keep it sweet.

Two ounces of corn meal to each quart of skimmilk has yielded the pound of pork at the least cost of food. A larger amount of corn meal has produced a more rapid growth, but at an increased cost for food for each pound of pork above its market value.

During heavy feeding in preparation for market, twelve quarts of skimmilk daily to each pig, with all the corn meal that would be eaten, produced a more rapid growth, and at less cost per pound, than six quarts of milk under similar conditions.

A method of feeding during the earlier months which tends to the development of bone, muscle and digestive organs, rather than the formation of

fat, provides a foundation on which greater profit will be made when heavy feeding begins in preparation for market. Any method of feeding which furnishes bulky food tends to the larger growth of the stomach and intestines and a larger per cent of shrinkage in dressing. Watery food has the same influence.

The eight pigs used in these tests increased in live weight 1918 pounds, which sold for \$112.91, while the food they ate cost \$73.68, a profit of \$39.23. The grain they ate cost \$44.11, which subtracted from the amount for which they sold, leaves \$68.70 as the amount realized for the 19712 pounds of skimmilk they ate, which is equivalent to 35 cents per hundred pounds. The fertilizing value of the food was \$38.09, or 51 per cent of its market value. Owing to the high price of pork at the time they were marketed, they could have been fed profitably to a greater weight than in our previous experiments, but even at seven cents a pound dressed weight they yielded no profit during the last period after they weighed on the average 250 pounds apiece, and at ordinary prices for pork profit would have ceased at about 200 pounds live weight.

POTATO BLIGHT.

It has been definitely ascertained that spraying potato vines will help to prevent the damage from potato blight. Trials with twelve different preparations showed that the strong Bordeaux mixture gave the best results, though good results were also obtained from Bordeaux mixture and molasses, from weak Bordeaux mixture and from modified eau celeste.

The gain from spraying varied widely. On the average in the tests the gain was about a hundred bushels. In other words, the crop from the sprayed plots was just about double that of the unsprayed. Three applications of the Bordeaux mixture produced on the average about one-third more gain than two applications.

The Bordeaux mixture costs about one cent per gallon. To make three applications requires from two hundred to five hundred gallons per acre, and the cost for labor in applying is about one dollar an acre for each application. The total cost, therefore, of spraying potatoes varies from \$3.50 to \$9.75 per acre, and averages about \$6; so that the profit from spraying is many times the cost of the application.

The increased yield obtained where the plants are sprayed is due principally to the longer life of the vines, allowing them to grow a larger yield of potatoes.

There are two potato blights, named, in order to distinguish them, the "early" and the "late blight." It is known that the late blight can be prevented by the Bordeaux mixture, and the indications are that much of the damage from the early blight can be prevented by the same. Spraying for the early blight should begin the first week in July; for the late blight, not until the last of July or the first of August.

OTHER PLANT DISEASES.

Much time has been spent by the Botanist in investigating several other plant diseases. It was found that where the red cedars in the vicinity of an apple orchard were destroyed that the apple rust, previously very bad in the orchard, entirely disappeared. A large orchard was sprayed thoroughly for the prevention of the apple scab; but the season was so wet the solutions were washed off as fast as applied, and the resulting gain in crop was not equal to the cost of the labor.

Several greenhouse diseases have been investigated and much information obtained concerning their occurrence and characteristics. The experiments for their prevention have not yet progressed far enough for a report. A peculiar trouble found on the tomato plants, and which seriously reduced the crop, was found to be due to an excess of water.

OAT SMUT.

Further experiments have confirmed the results obtained a year ago that soaking the seed-oats in hot water entirely destroys the smut. An increase of yield in addition to that produced by the smut spores has been reported by several investigators. In the tests made last summer no such increase was observed. A very extended investigation showed that the loss from oat smut in this State, where *native* seed is used, is about one per cent, and therefore not large enough to demand the use of the hot water for any other treatment than for disinfecting the seed. It also showed that the average loss from oat smut where Western seed is used is much greater than where native seed is used, being in the samples examined over three times as great.

VARIATIONS IN QUANTITY AND QUALITY OF MILK.

A full record has been kept at the Station of the milk of each cow, year after year, and many thousand analyses made. The voluminous records now on file furnish abundant data for determining the changes that take place in the quantity and quality of the milk of a cow, and the influence that various circumstances have on the quantity and quality.

A study of these records leads to the following conclusions:

1. All cows shrink in quantity of milk as they get farther from calving. If they are farrow this shrinkage in quantity is accompanied by almost no change in quality, even until they go dry, provided they are still farrow. If they are in calf the milk increases in quality as it decreases in quantity. This increase is slight, but one-twentieth during the first six months after calving, but becomes quite pronounced just before the cow goes dry.

2. Cows that calve in the spring average giving more milk during the first three months after calving than those that calve in the fall. For the

seventh, eighth and ninth month this is reversed. Fall cows show smaller variations in the quality of the milk than cows that calve in the spring.

3. The milk of a cow for the first few days or weeks after calving is very variable in quality. On the average it is thinnest just after calving, becomes slightly richer during the next two weeks, and then holds almost uniform in quality for the next four or five months.

4. Cows vary in the quality of their milk from one milking to the next, and from day to day, the quality rising and falling without apparent cause. Such changes are usually within one per cent of fat, but one cow was known to change 2.68 per cent in two days. The least change of any of the cows in the Station herd during an entire period of lactation is 0.33 per cent fat, the average change 1.34 per cent, and the greatest change 2.78 per cent. The largest variation in yield of butter is from milk that required twenty pounds of milk to make a pound of butter to a quality of milk which would require but 11.7 pounds. It is probably possible that cases may occur of a doubling of the richness in the milk during different times in the same period of lactation.

5. Just after calving the milk is poorer in fat and in solids not fat than just before the cow went dry. The average drop in fat is 1.13 per cent the greatest change being 2.35 per cent and the least 0.49 per cent. The average change in solids not fat is a fall of 0.47 per cent, with variations from a decrease of 1.94 per cent to an increase of 0.42 per cent.

6. Most cows give about the same quality of milk year after year, beginning with this quality at the first calving. There is no general tendency for the milk to become either richer or poorer as the cow grows older.

7. From one calving to the next cows may be expected to vary the general quality of their milk not much more than a sixth of one per cent of fat, and scarcely ever will show a variation of more than a quarter of one per cent.

8. The milk of a heifer tends to agree very closely in quality to that of her dam. The average variation is a third of one per cent of fat, and the greatest difference is one per cent, in the case of an Ayrshire cow crossed with a Jersey bull.

9. The present cheap, rapid and easy methods of testing cows leaves no excuse for any dairyman's not knowing the quality of the milk of each one of his cows. If two tests are made each of a mixed sample of four day's milk, one being taken six weeks after the cow calves and the other six months after calving, the average of these two tests will agree almost exactly with the average quality of the milk given during the entire milking period. There will seldom be a difference of as much as a quarter of one per cent of fat.

10. If it is desired to know from tests nearer together what quality of milk a cow gives, very accurate results will be obtained by making two

tests fifteen days apart, four months after the cow calved, each test being on a mixed sample of four day's milk. The average of these two tests with one-eighth of one per cent of fat added is surprisingly near the truth for the average quality of the year's milk.

11. In the long run, just the same results are obtained whether cows are tested once a month or twice a month.

12. Cows that have been properly fed at the barn do not shrink in quality of milk when turned to pasture. They usually increase both in quality and quantity.

13. Full feeding with grain at the barn and while the cows are on pasture, produces a much larger flow of milk during April and May, and causes the milk flow to keep up considerably later in the fall. No attempt was made to ascertain whether this increase was sufficient to pay for the extra grain.

14. The milk produced by the cows of Vermont during the entire year contains on the average 4.11 per cent of fat, and would if rightly handled make a pound of butter from each 22 pounds of milk.

15. The Station herd was troubled with abortion, and the trouble ceased after thorough disinfecting with sulphur and a plentiful use of laudanum. There is nothing to prove conclusively that the treatment was the cause of the cessation of the disease.

16. The most noticeable effect of abortion on the quality of the milk is to make it richer than it would have been had the cow gone full time. This quality, however, falls during the first few months after abortion, until by the third or fourth month it is of about the same quality as would have been given if the cow had calved naturally.

17. The worst effect of abortion is the decreased quantity of milk given, which with the cows of the Station amount to about a third of the full yield.

RECORD OF THE STATION HERD FOR THE YEAR 1892.

Careful and very complete records of the Station herd were kept during the year 1892, and showed that the twelve regular members of the herd averaged 7197 pounds of milk, of such quality as to make 351 pounds of butter each. The records also showed that the herd contained on the average twenty-one cows, and that these produced 7028 pounds of milk apiece and 384 pounds of butter.

The best Ayrshire gave 8055 pounds of milk and 345 pounds of butter; the best Holsteins 9810 pounds of milk and 388 pounds of butter; the best three Jerseys, 7130 pounds of milk and 422 pounds of butter. The best record of any cow in the herd within the year was 12,224 pounds of milk and 506 pounds of butter.

RELATIVE VALUE OF A COW FOR CHEESE MAKING AND BUTTER MAKING.

When the records of the various cows in the Station herd are compared as to the amount of butter and of cheese that could be made from their milk, it is found that if $2\frac{1}{2}$ pounds of cheese are considered to be equal in market value to one pound of butter, then for every one hundred dollars obtained from the Jersey milk made into butter there would be received ninety-five dollars if the milk had been made into cheese. The relation with the Ayrshire milk is as 100 to 97, and with the Holstein as 100 to 98, the poorer milk being a little better adapted to cheese making than the richer milk, but the differences are not large. The important fact is brought out that they are all good for butter and all good for cheese; and that, therefore, the so-called "cheese cow," that is, the cow which is especially good for cheese rather than butter, does not exist; and, that wherever a cow is found that is good for cheese making purposes, the milk of that cow is equally good for the manufacture of butter.

AERATION OF MILK.

An extended series of tests with two different kind of Aerators, and under several different sets of conditions, leads to the conclusions:

1. That the aeration of milk without cooling has no effect on the creaming of that milk, but if the milk is cooled during the aeration the creaming of the milk will be less perfect.
2. Any method of aerating milk that does not at the same time cool it does not make the milk keep longer before it sours, but the cooling of the milk as soon as it is drawn from the cow will retard the time of souring.

THE EFFECT OF WEATHER UPON THE QUANTITY AND QUALITY OF MILK.

A second investigation of this matter was made on the Station herd during the summer of 1892. The results of this test agree closely with those of the year previous, and indicate a strong probability that when cows are on pasturage the quality of the milk varies with the temperature, but in the opposite direction, the milk becoming richer during cold weather, and poorer during warm weather. The same variations are found to be true of the total solids of the milk, and of the solids not fat. In regard to quantity of the milk, violent changes in temperature either way, very hot or very cold, seem to lessen the quantity. Rain storms, unless very heavy, do not seem to affect either the quantity or quality of the milk to any marked degree. There seems no reason for changing the explanation given in the last report for this richness of the milk during cold weather, that as the temperature falls the cow actually consumes more food, and thus there is present in the system a larger amount of material from which to produce richer milk.

TESTS OF DAIRY APPARATUS.

At the second session of the Dairy School, held in October and November, 1892, four power separators and three hand separators were tested, and also full analyses made of the milk and of the milk products. The average for all the machines for all the tests gave 0.13 per cent of fat left in the skimmilk, 1.27 per cent in the bowl slop, and 0.30 in the buttermilk. The butter contained on the average 83.16 per cent of fat. The average temperature at the beginning of churning was 54°, and at the close 58°, the average time of churning being 31 minutes. The sum of the fat left in the skimmilk, bowl slop and buttermilk, amounted on the average to 3.20 per cent of the entire fat of the original whole milk, so that if there were no mechanical losses there should have been made 121 pounds of butter containing 80 per cent of fat for 100 pounds of fat in the original milk. But under the conditions of student labor and the large number of persons engaged in handling the butter, there were unavoidably large mechanical losses, on the average 3.4 per cent of the entire fat, so that there was really obtained only 117 pounds of butter for each hundred pounds of butter fat.

The students and instructors of the Dairy School were especially pleased with the new form of Babcock testing machine, which is run by a jet of steam that whirls the bottles, without the use of any engine, and at the same time keeps them hot. The churning figures show that the colder the temperature at which the cream was churned the less fat there was lost in the butter milk, and a larger amount of fat in each hundred pounds of the butter. The losses were greatest when the churning temperature was from 59° to 61°, and the time of churning was the least

FEEDING TESTS WITH CONCENTRATED FEEDS.

Experiments in feeding were made with four concentrated feeds that have lately come on the market: Cream Gluten Meal and Corn Germ Feed, from the Chas. Pope Glucose Company; Buffalo Gluten Feed, from the American Glucose Company; and Oat Feed, being the refuse of the oat meal mills. These were compared as to their feeding value in some of the experiments with a mixture of equal parts by weight of wheat bran and corn meal, and in other experiments pound for pound with corn meal. The results show that they undoubtedly have a very high feeding value.

With the first three feeds mentioned, thirty-six experiments were made, seventeen comparing with a mixture of bran and corn meal, and nineteen comparing directly with corn meal. In almost every case cream gluten meal and Buffalo gluten feed produced more milk and more butter fat than an equal weight of bran and corn meal, or of corn meal. In twenty-four cases out of the thirty-six, the milk produced when eating these concen-

trated feeds was richer than on the bran or the corn meal, but the exceptions are numerous and the added fact that the same cow at different times gave different results would seem to indicate that the individuality of the cow is the leading feature in the result, and that it cannot be said with any certainty that these feeds will increase the richness of the milk.

The results seem to show that the Buffalo gluten feed and the cream gluten meal have each a higher feeding value than the mixture of bran and corn meal, and are worth more pound per pound than clear corn meal, while the corn germ feed and the oat feed seem to have just about the same feeding value as the mixture of bran and corn meal.

As these feeds can be obtained at the same, or even a less price than corn meal, they appear to be some of the most economical for the farmer to purchase. It must always be remembered in feeding the cream gluten meal and the Buffalo gluten feed, that they are very rich, concentrated feeds, and must be used with great caution. This is especially true of the cream gluten meal, which can hardly be fed with safety at a greater allowance than two pounds per day per cow. From three to four pounds per day per cow should be the most ever fed of the Buffalo gluten feed.

SOILING WITH CORN ENSILAGE.

The Station has had a very successful experience in keeping ensilage through the summer and feeding it as a soiling crop to help out the pasture, especially in the fall when the pastures begin to fail. It was even found that when this ensilage was replaced by fresh fodder corn cut green from the field the cows did better on the ensilage than on the fodder corn. It is probable that under New England conditions ensilage will be found to be by far the most economical soiling crop.

FOUR WAYS OF PRESERVING FODDER CORN.

Six acres of fodder corn from the three fields of the Station in the fall of 1892, were harvested in such a way that they were divided into four exactly equal parts. One-fourth was run through the cutter and cut into quarter inch pieces, and put into the silo ears and all. This was called "whole ensilage." The second quarter, called "stover ensilage," had the ears picked off in the field, then the stalks run through the cutter and put into another silo. The ears after lying on the ground for a few days were brought to the barn, husked, and the ears dried and ground into cob meal. The husks were run through the cutter, and together with the meal, fed to the cows that were eating the stover ensilage. The third part, called the "corn fodder," was placed in large stooks near the barn, the top of the stooks being bound very tightly so as to shed rain and snow, and as fast as needed this corn fodder taken into the barn, run through the cutter, and fed ears and all together. The last quarter, called the "corn stover," was

treated the same as the corn fodder, except that when it was taken into the barn the ears were picked off, dried and ground, and the resulting meal fed at the same time with the cut stalks.

Twelve cows were used, divided into four groups, and the manner of feeding was so arranged that each cow was fed at one time or another on each of the four portions, and at the end of the experiment, which lasted five months, there had been the same number of cows for the same number of days on each one of the four portions.

Each cow was given ten pounds of very fine clover rowen, three pounds of wheat bran, and two pounds of corn meal daily, and in addition all she would eat of the fodder corn in some form or other.

The experiment went through very successfully. The corn kept well in all the different ways, was relished and well eaten by the cows, and none of the cows were sick or even off their feed during the whole five months. Every milking was weighed and the milk analyzed for twenty-four milkings out of each feeding period, which lasted twenty-eight days. Full records were kept of weights as harvested, amounts fed,orts and residues, with a very large number of samples for chemical analysis.* The results, briefly stated, are as follows:

DRY MATTER SAVED.

The whole ensilage lost 18 per cent of the dry matter in the original crop as harvested; that is, there was saved for feeding 82 pounds of dry matter for every 100 pounds in the original crop as harvested. The stover ensilage lost 21 per cent of dry matter, the corn fodder 18 per cent, and the corn stover 17 per cent; average of all 18 per cent. Three of the methods, therefore, gave almost identical results. The slightly better showing of the corn stover over the corn fodder can be accounted for by its being brought into the barn from a week to ten days earlier each time for husking. The stover ensilage showed the largest loss, and this loss seems to have been due to the heavy rains that fell on the ears and husks while they were lying in the field before they were brought to the barn. The stalks of the stover ensilage kept just about as well in the silo as the whole ensilage. The same result was found in a similar experiment two years ago, *i. e.* that stooked corn fodder under the best conditions kept with as little loss as good ensilage. But, while the ensilage in this experiment was handled with no more care than is given by most farmers with silos, the stooked fodder was treated much more carefully than is ordinarily done on the farm, and the losses here given of 18 per cent are probably much less than those usually experienced in this State.

RESULTS OF FEEDING.

There was essentially the same return in milk, total solids and fat from the four methods of handling the corn crop. These results will probably be

a surprise to many who would expect to see the ensilage surpass the stooked fodder, and more of a surprise to the still larger number who would expect decidedly better returns where the corn was husked and ground than where it was fed whole on the ear, or put whole into the silo. In milk yield the whole ensilage does the best, and the stover ensilage the poorest, but these differences are only 8.3 per cent, or one-thirtieth of the total yield. It would be difficult to get any closer results if the cows had been fed without change of rations during the entire winter.

Even the slight differences disappear if the average of the two ensilages is compared with that of the two stooked fodders, or if the average of the two parts in which the ears were separated from the stalks and fed as meal is compared with the average of the parts in which the ears and stalks were fed together without grinding. The results may be fairly interpreted to mean, that all four ways of handling the corn crop preserve it in good, palatable condition, and if the cows are allowed to eat all they want they will give about the same returns during the same number of days from each method.

There was also no essential difference in the quality of the milk from these four methods, either in total solids, fat, or solids not fat.

AMOUNT EATEN BY THE COWS.

The cows were given all they wanted, and it is fair to presume that they ate enough to satisfy the demands of the system. If the fodder was less digestible or nourishing they ate more of it, and when a less quantity of a different kind supplied their needs they dropped off in the amount they took. There was quite a decided difference in the amount of dry matter eaten per day per cow in all of the different kinds of fodder. The cows on whole ensilage consumed on the average 9.16 pounds of dry matter from the corn crop daily; the cows on the stover ensilage, 10.88 pounds of dry matter; those on corn fodder, 10.01, while the cows that were eating corn stover ate the largest amount daily, consuming 11.86 pounds of dry matter each from the corn crop. Though producing equal quantities of milk, the cows ate much less of the whole ensilage to produce this milk than they did of any of the others. The greatest amount of feed to produce the average yield was required by the cows eating corn stover. Each of the ensilage lots makes a better showing than the corresponding stooked portion, and each case where the corn was ground makes a poorer showing than its mate fed without husking or grinding.

TOTAL YIELDS.

The last eighteen days of each period was considered the experimental period. Had all of the crop been fed under the conditions of the experimental periods the amounts of milk and fat given in the following table would have been produced:

Kind of Fodder.	Total Dry Matter Saved Ready for Feeding. lbs.	Dry Matter Fed Dur- ing Exper- imental Periods. lbs.	Calculated Yield of the Whole Crop.	
			Milk. lbs.	Fat. lbs.
Whole Ensilage.....	6,173	2,473	12,169	498
Stover Ensilage.....	5,978	2,936	9,598	396
Corn Fodder.....	6,169	2,703	10,782	450
Corn Stover.....	6,239	3,149	9,680	394

WHICH FODDER LASTED THE LONGEST?

The figures just given of the comparative yields are open to the objection that different quantities of the non-experimental fodder (the clover rowen and the grain) would have been fed to produce them. There is another method of comparison which is not open to this objection. It was noticed in feeding the crops from the three fields that in each field the corn stover gave out first, and that there was always more of the whole ensilage left than either of the other portions. In other words, the whole ensilage lasted the longest, and each of the others will be compared with it. If the corn stover had been fed until it was all eaten up, and the whole ensilage had been fed the same number of days, the butter produced by the two feeds would have been exactly the same, but there would have been a great deal of the ensilage left, enough to have contained 1277 pounds of dry matter, or 26 per cent. of the entire amount of the dry matter in the ensilage. It is evident, then, that the whole ensilage has lasted so much longer than the corn stover, that the same results would be obtained by planting less land if the crop is to be fed as ensilage than would be required if the crop is to be handled as corn stover. In other words, one acre of corn made into whole ensilage yielded just as much return as 1.26 acres made into corn stover. Calculating in the same way for the other methods, it is found that an acre of whole ensilage is equivalent to 1.08 acres of corn fodder, or 1.26 of stover ensilage.

The above is the comparison on the basis of the production of equal quantities of butter. If the comparison were made of equal products of milk, the relative advantage of the whole ensilage would in each case be slightly increased.

THE EFFECT OF DRYING AND GRINDING ON DIGESTIBILITY.

A comparison of the records from the whole ensilage and the stover ensilage shows that the ears and husks of the whole ensilage in the silo lost but 15 per cent of their dry matter, while the ears and husks of the stover

ensilage, lying out on the ground in the wet weather and afterwards brought to the barn, lost 28 per cent. The cows on the stover ensilage ate more dry matter both of stalks and ears than those on whole ensilage, and gave even less milk. As there is no reason to believe that the stalks of one ensilage were any different from those of the other, it follows logically that the dry matter in the ears and husks that had been dried and ground was of less value, that is, less digestable value, than that of the ears and husks of whole ensilage. The same conclusion is reached with even stronger probability from a comparison of the yields from the corn fodder and corn stover, which differed only in the corn of one being ground and the other fed whole.

RELATIVE COST OF THE FOUR METHODS.

The labor required in feeding was largely in favor of the ensilage as compared with the whole corn fodder. How much stronger then is the comparison between whole ensilage and either of the methods in which the corn was harvested and ground. Leaving out of account the bad effects of the drying and grinding, there is still a complete loss of all the labor and expense of the extra work. The cost of harvesting and grinding the corn in this State will be about 16 cents per each bushel of 56 pounds of corn meal, not counting the labor or expense of carrying to the mill. This is more than a quarter of the total value of the meal, and, according to the results of these experiments, is labor and money worse than wasted.

CONCLUSIONS.

1. All four methods produced a good fodder, well preserved and relished by the cows.
2. The whole ensilage, the corn fodder and the corn stovers saved about the same amount of dry matter ready for feeding; the stover ensilage saved three per cent. less than the others; the average of all was 82 per cent. saved, 18 per cent. lost.
3. There was no great difference in the amount of milk or butter produced by the different methods. The difference between the best, the whole ensilage, and the poorest, the stover ensilage, was about 3 per cent. The average of the two ensilages was the same as that of the two stoked fodders. The same is true of the average of the two stovers as compared with that of the two whole fodders.
4. The four methods of handling the crop produced no effect on the quality of the milk.
5. The cows ate very different quantities of dry matter when on the different portions to produce equal quantities of milk and butter.
6. For each 100 pounds of dry matter of the whole ensilage eaten,

the cows ate 119 pounds of dry matter in the stover ensilage, 109 pounds from the corn fodder and 127 pounds of dry matter from the corn stover.

7. If all of each fodder had been fed out under the conditions of the experimental periods, with corresponding amounts of rowen and grain, the stover ensilage would have produced 82 pounds of milk for each 100 pounds produced by the whole ensilage. The corn fodder would have produced 92 pounds and the corn stover 82 pounds. The proportions are much the same with regard to the yield of butter.

8. One acre of the corn crop preserved as whole ensilage and fed with 4,313 pounds of clover rowen and 2,157 pounds of grain, produced 8,113 pounds of milk, 1,067 pounds of total solids and 398 pounds of butter.

9. The whole ensilage lasted the longest every time. Consequently it would take less of it to last a herd for a given time. One acre of corn made into whole ensilage yielded as much return in milk and butter as 1.26 acres made into stover ensilage or 1.08 acres made into corn fodder or 1.26 acres handled as corn stover.

10. The drying and grinding of the ears of the stover ensilage and corn stover seem to have made them less digestible, and this is the reason why these portions have done so much poorer than the whole ensilage.

11. Husking, shelling and grinding the corn to make a bushel of meal costs in this State 16 cents, or more than a quarter of the market value of the meal.

12. This labor and expense is more than wasted, since the cows did better on the whole corn than on the ground.

13. Dry corn fodder after being brought into the barn is still undergoing fermentation and loss even when no heating can be detected. In the course of ten days this loss may easily be half as much as took place in the stook. These changes and losses take place less rapidly in cold weather than in warm.

14. The losses of dry matter and feeding value in ensilage are closely proportional to the losses in weight.

15. The ensilage at the time of usual opening of the silo has in it still nearly all the feeding value that it had when put into the silo.

16. The large losses of feeding value that occur in the silo are almost entirely at the time of feeding out the ensilage.

17. These losses can be largely prevented by using small, deep silos that will allow the feeding of two to three inches from the surface daily.

18. This is especially true of ensilage to be used in place of a soiling crop in summer.

19. The ensilage in the lower portions of a silo is not so compressed and solid at the time of feeding as would be expected from its weight at the time the silo was filled.

LOSSES IN STOOKING AND ENSILAGING.

There is a general belief that after corn fodder has once dried out in the stook, it can be handled over, stacked or put in a mow, and if it shows no signs of heating, no further loss of dry matter will occur. The results obtained in this experiment show that all corn fodder when losing in weight is also losing in dry matter, and consequently in feeding value. In some cases the losses in ten days, without any apparent heating, were half as much as all that had been lost while standing in the stook most of the winter. There has also been a tendency in agricultural papers to allow a high shrinkage in weight of ensilage, usually 20 to 25 per cent, and still claim but small loss in feeding value. In six experiments at the Vermont Station and eight at the Wisconsin Station, the average losses in feeding value are fully as great as those in gross weight.

These losses in ensilage occur mainly from the action of the air at the time of feeding. They can be largely reduced by having the silo narrow and deep, so that from two to three inches of depth is fed off daily.

ABSTRACTS OF BULLETINS.

BULLETIN No. 28.

PLANT DISEASES.

By L. R. JONES.

SUMMARY.

The following are the principal facts and conclusions presented in this bulletin :

I. POTATO BLIGHT AND ROT. The Bordeaux mixture again during the season of 1891 proved an effective remedy for the blight and rot, the tests being made both at the Experiment Station and in the fields of several potato growers about the State.

II. A NEW POTATO DISEASE. A disease somewhat similar in general appearance to the blight was quite prevalent in the State last year. It is especially desirable that farmers learn to distinguish between the old and the new disease. No certain remedy for the new disease has yet been found.

III. POTATO SCAB. It has been definitely settled that the scab is caused by a fungus growing on the potato tuber. The scab is found to be increased when scabby potatoes are used for seed ; when barnyard manure is used from stock to which scabby potatoes have been fed ; when the potatoes are planted on the same land year after year. The germs of the disease may be killed by soaking the seed potatoes for an hour and a half in a solution of one part of corrosive sublimate dissolved in a thousand parts of water.

IV. APPLE AND PEAR SCAB. These diseases are much the same, are both caused by fungous growths and can be largely prevented by spraying the trees with various copper solutions.

V. OAT SMUT. This is a fungous disease, and can be entirely prevented by soaking the seed oats in hot water. This treatment appears also to improve the germination of the seed.

ABSTRACT OF BULLETIN No. 29. ANALYSES OF LICENSED FERTILIZERS.*— BY J. L. HILLS.

Station Number.	BRAND.	NITROGEN.				PHOSPHORIC ACID.						POTASH.							
		Valuation at		Station Prices.	Soluble.		Rev't'd.		Ins't'ble.		Available.		Total.	Valuation at Station Prices.	Guaranteed.	Found.	Valuation at Station Prices.	Guaranteed.	Found.
		Found.	Guaranteed.		Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.							
4157	Bradley's X. L. Superphosphate.	2.67	2.50	\$8.54	6.84	7	2.89	2	1.64	2	9.73	9	11.87	11	\$14.97	2.41	2.00	\$2.17	
4158	Bradley's Corn Phosphate.	2.56	2.50	8.19	5.87	7	4.69	2	2.16	1	10.06	9	12.22	10	15.49	1.79	1.50	1.61	
4159	Buffalo Ammo. Bone Superphos	3.00	2.90	9.60	6.84	7	2.08	3	0.92	1	9.02	9	9.94	10	13.68	1.91	1.00	1.72	
4161	Cumberland Potato Fertilizer.	2.28		7.80	6.15	3	3.50		1.94		9.65	9	11.59		14.91	3.73	3.00	3.86	
4162	Bradley's Potato Manure.	2.67	2.50	8.54	2.95	5	2.96	1	2.69	2	5.91	6	8.60	10	10.15	5.25	5.50	4.72	
4163	Bradley's Eclipse Fertilizer.	1.93	1.	6.18	6.70	8	2.77	2	2.65	2	9.47	10	12.12	12	14.99	1.94	1.20	1.75	
4164	Buffalo Potato, H. & T. Fert.	2.25	2.	7.20	5.18	7	2.08	3	2.85	1	7.26		10.11	10	11.82	3.47	3.60	3.12	
4165	Buffalo New Rival Ammo. Super	1.53	1.20	4.90	6.00	8	2.62	2	3.68	1	8.62		12.30	10	14.14	1.75	1.60	1.57	
4166	Buffalo Ammo. Wheat and Corn	2.28	2.	7.80	6.47	6	1.81	4	2.69	1	8.28		10.97	10	13.32	2.17	1.00	1.95	
4167	Cumberland Superphosphate	2.52	2.50	8.06	6.27	3	3.30		2.18		9.57	8	10.75	10	14.90	2.19	2.00	1.97	
4168	Quinnipiac Phosphate	2.80	3.	8.96	6.48	6	2.81	3	2.54	1	9.29	9	11.53	10	14.55	1.77	2.00	1.59	
4169	Bowker's Sure Crop Bone Phos.	1.25	0.82	4.00	8.70		1.16		2.52		9.86	8	12.38	10	15.68	2.01	1.00	1.81	
4170	Bowker's Farm and Garden Phos	2.26	1.64	8.19	6.44		1.88		3.68		8.32	8	12.00	12	13.76	2.85	2.00	2.11	
4171	Quinnipiac Potato Manure	2.77	3.	9.86	3.53	4	2.16	2	2.69	1	5.69	6	8.38	7	9.40	5.17	5.00	4.65	
4172	Bradley's Potato Fertilizer	2.38	2.50	7.62	7.61	7	2.44		1.40		10.05	9	11.45	11	15.39	2.65	6.00	2.88	
4175	W. & C. American Potato, etc.	2.47	2.50	7.90	7.84	6	2.95	1.50	1.35	1	10.29	8	11.64	9	15.68	3.55	3.00	3.19	
4176	W. & C. American Corn Phos	2.41	2.50	7.90	7.88	7	2.51	2	1.71	1	10.34	9	12.05	10	15.94	1.97	1.00	1.77	

*Licensed for sale in the State during the year 1892.

ANALYSES OF LICENSED FERTILIZERS.

Station Number.	BRAND.	NITROGEN.			PHOSPHORIC ACID.						POTASH.						
		Valuation at Station			Soluble.		Revert'd.		Ins't'ble.		Available.		Total.		Valuation at Station		
		Found.	Guaranteed.	Prices.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.	Prices.
4177	Bowker's Stockbridge Manure	3.43		\$10.98 5.72			3.10		2.12		8.22		10.94		\$13.77 5.56		\$5.05
4178	Bowker's Potato Phosphate	2.63	2.56	8.42 6.91			1.95		3.04		8.86	7	11.90	11	14.32 2.64		2.38
4179	Coe's Special Potato Fertilizer	2.28	1.90	7.30 5.96	7		2.22	2	1.55	1	8.18		9.73	9	12.67 4.61	3.50	4.15
4180	Coe's St'd'rd Ammo. Bone Super	2.03	1.75	6.50 6.66	6		2.73	2	1.88		9.39		11.27	8	14.56 2.00	1.08	1.90
4184	Coe's High Gr. Ammo. Bone Super	2.17	2.06	6.94 7.34	7		2.87	2	2.32	2	9.71	9	12.03	11	15.26 2.34	1.62	2.11
4185	Sol. Pac. Guano Spec. for Potato	2.70	2.06	8.64 6.00	6		3.65	2	2.05	1	9.65	8	11.70	9	14.93 2.41	3.00	2.17
4186	Soluble Pacific Guano	2.51	2.25	8.03 7.11	7		2.18	1.50	2.30	2	9.26		11.59	10.50	14.64 2.53	2.00	2.28
4187	Cleveland Superphosphate	2.47	2.05	7.90 6.94	7		2.77	2	2.21	2	9.71	9	11.92		15.17 2.08	2.00	1.87
4188	Cleveland Potato Phosphate	2.26	2.05	7.23 6.84	6		2.64	2	1.61	2	9.48	8	11.09		14.60 4.16	3.00	3.74
4189	Lister's Success Fertilizer	2.07	1.23	6.62 6.78			1.80		2.81		8.58	9.50	11.39		13.81 2.25	1.50	2.02
4190	Bradley's B. D. Sea Fowl Guano	2.87	2.50	9.18 6.43	7		3.23	2	1.84	2	9.66	9	11.50	11	14.91 2.24	2.00	2.01
4191	Bradley's Original Coe's Super	2.42	2.06	7.74 7.45	6		2.80	2	2.14	2	9.75	8	11.89	10	15.26 1.80	1.00	1.72
4192	Standard Vermont Favorite	1.36	1	4.35 6.56	8.50		2.62	2	1.91	2	9.18	10.50	11.09	12.50	14.27 1.88	1.50	1.69
4193	Standard Fertilizer	2.30	2	7.36 7.29			2.46		2.08	2	9.75	8	11.83	10	15.18 2.17	2.00	1.95
4194	St'd'rd Potato and Tobacco Fert	2.31	2.05	7.39 7.68			2.64		1.50	1	10.82	8	11.82	9	15.82 2.67	3.00	2.40
4195	Lister's Celeb'rted Corn Manure	3.52	3.69	11.26 5.17			1.36		1.61		6.53		8.14	7.50	10.29 6.45	7.00	5.80
4198	Bowker's Hill and Drill Phos	3.09	2.50	9.89 6.49			3.62	2	2.02		10.11	8	12.13	12	14.72 1.85	2.00	1.66

**COMPARATIVE VALUE OF FERTILIZERS LICENSED
IN 1891 AND 1892.**

Of the forty brands of commercial fertilizers sold in the State during the years 1891 and 1892, sixteen standard brands have been selected for a comparison between the character of the goods sold under these brands in each of the two years. Only those brands were selected which have been sold in the State during both of the years.

AVERAGE COMPOSITION IN 1891.

Name of Fertilizing Ingredient.	Pounds in a hundred.	Pounds in a ton.	Price per pound.	Valuation at 1892 prices.
Nitrogen.....	2.35	47	16	\$7 52
Soluble Phosphoric Acid.....	6.52	130	7½	9 78
Reverted Phosphoric Acid.....	3.01	60	7	4 21
Insoluble Phosphoric Acid.....	1.96	39	2	0 78
Available Phosphoric Acid.....	9.53	191		
Total Phosphoric Acid.....	11.49	230		
Potash.....	3.03	61	4½	2 73
Total valuation per ton.....				\$25 02

AVERAGE COMPOSITION IN 1892.

Name of Fertilizing Ingredient.	Pounds in a hundred.	Pounds in a ton.	Price per pound.	Valuation at 1892 prices.
Nitrogen.....	2.53	51	16	\$8 10
Soluble Phosphoric Acid.....	6.13	123	7½	9 20
Reverted Phosphoric Acid.....	2.70	54	7	3 78
Insoluble Phosphoric Acid.....	2.29	46	2	0 92
Available Phosphoric Acid.....	8.83	177		
Total Phosphoric Acid.....	11.12	222		
Potash.....	2.92	58	4½	2 63
Total valuation per ton.....				\$24 63

A comparison of the average composition for the two years shows that more nitrogen, less potash, and much less phosphoric acid, and less money value by \$0.39 per ton was furnished in the average fertilizer in 1892 than in 1891. The average valuation this year is lower than that of any previous

year since the Experiment Station began sampling and analyzing licensed fertilizers under the State law. Notwithstanding the fact that the market price of available phosphoric acid has decreased so as to warrant its valuation being lowered a half-cent per pound, yet fertilizer manufacturers have decreased the amount of this ingredient in their goods by \$1.08 per ton. This is partially counterbalanced by the increased amount of nitrogen.

The average nominal selling price of the brands included in the tabulations, which constitute the great bulk of all sold in the State, has decreased twenty-seven cents, but fertilizer agents have given more concessions than usual this spring, and on the entire business of the State, it is probable that the decrease in actual cost to the farmer is fully equal to the decrease in value, so that he is obtaining the plant food this year at about the same price as last year.

REPORT OF THE CHEMIST.

By J. L. HILLS.

ANALYSES OF MISCELLANEOUS FERTILIZING MATERIALS.

ANALYSES OF ASHES.

Station Number.	Source and Character.	Soluble Potash %
4211.	W. C. Cushing, Brattleboro.....	2.44
4212.	W. M. Howe, Vernon.....	7.42
4217.	Alonzo Stebbins, Vernon.....	5.70
4221.	M. R. Lawrence, Bartonville.....	1.82
4222.	W. H. Cole, Westminster.....	4.87
1047.	“ “ rock maple ashes.....	9.00
1048.	“ “ Canada ashes.....	4.96
1049.	E. O. Lee, Vernon.....	5.96
1053.	A. A. Duncklee, Vernon; Vermont ashes.....	6.68
1054.	“ “ Canada ashes.....	4.44
1055.	“ “ “ “.....	2.81

ANALYSES OF PEAT, MUCK AND PEAT ASHES.

Station Number.	Character and Source.
4204.	Peat, upper layer, George Aitkin, Woodstock.
4205.	Peat, lower layer, “ “
4218.	Dried muck, L. H. Sheldon, Fairhaven.
4219.	Peat ashes, upper layer, John Webster, Franklin.
4220.	“ lower “ “

ANALYSES.

Station Number.	Character.	Water.	Ash.	Volatile and Organic Matter.	Nitrogen.	Phosphoric Acid.	Total Potash.	Soluble Potash.
4204	Peat.....	65.92	6.57	27.51	1.22			
4205	Peat.....	77.04	2.05	20.91	0.41			
4218	Dried Muck.....	4.45			2.68			
4219	Peat Ashes.....					1.00	0.63	0.80
4220	Peat Ashes.....					1.37	0.16	0.00

ANALYSES OF TANKAGE, BONE MEAL AND PHOSPHATE.

Station Number.	Character and Source	Nitrogen. %	Phos- phoric Acid. %
4199.	Tankage, Great Eastern Fert. Co., Rutland.....	8.97	3.22
4200.	Bone Meal, " "	1.95	29.20
1050.	Bone Meal, L. C. Fisher, Cabot	3.52	20.21
1051.	Bone Meal, " "	3.75	24.50
1052.	Bone Meal, " "	3.90	26.22
1056.	Odorless Phosphate, A. A. Duncklee, Vernon.....		18.87

1046.

BAY STATE FERTILIZER.

Sample from George J. Perkins, Hardwick.

Nitrogen.....	2.94
Soluble Phosphoric Acid.....	7.09
Reverted Phosphoric Acid.....	2.56
Insoluble Phosphoric Acid.....	2.07
Available Phosphoric Acid.....	9.65
Total Phosphoric Acid.....	11.72
Potash.....	2.07

ANALYSES OF DRINKING WATER.

Station Number.	Character of Water.	Source of Sample.	Parts per Million.		Grains per Gallon.	
			Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Total Solids.
1866*	Spring.	E. H. Hatch, Burlington.....	0.095	0.165	0.35	11.2
1867	"	C. J. Shedd, Richmond.....	0.01	0.10	0.20	
1868*	Well.	W. E. Weller, Burlington.....	0.035	0.18	2.00	32.46
1871		W. H. DuBois, West Randolph...	0.01	0.125	0.30	13.18
1872		" " " ".....	0.01	0.11	0.30	7.62
1873*		Corinth Creamery.....	0.17	0.20	0.30	8.61
1874*		J. H. Bates, Proctorsville.....	0.095	0.175	0.20	
1875*		" " " ".....	0.115	0.14	1.35	
1876*		" " " ".....	0.025	0.15	0.20	
1878*		Charles Kenyon, Hinesburgh.....	0.72	0.19	0.30	
1879		Dr. H. C. Tinkham, Burlington...	0.00	0.065	2.50	
1880	Spring.	E. C. Orvis, Manchester.....	0.00	0.08	0.20	
1881	"	" " " ".....	0.00	0.00	0.20	

Standard of purity, etc., may be found by reference to previous reports.
 Samples marked with an asterisk (*) were considered unfit for use.

ANALYSES OF MAPLE SUGAR.

Station Number.	Source of Sample.	Per cent. Sugar.
1850.	G. R. Kenfield, Fairfield.....	89.0
1852.	W. R. Bliss, Corinth.....	81.0
1853.	W. H. Chapman, W. Rutland.....	85.0
1854.	W. F. M. Fitts, West Corinth.....	75.6
1855.	W. H. Smith.....	76.6
1856.	Williams.....	82.9
1857.	".....	95.2
1858.	".....	83.1
1859.	".....	92.3
1860.	B. D. Longe, Burlington.....	81.9
1861.	.....	84.4
1862.	H. E. Bostwick, Burlington.....	81.6
1863.	A. E. Lamson, Williston.....	77.6
1870.	L. R. Tabor, Westford, made in May.....	77.7
1877.	H. A. Bartlett, Morgan.....	81.2
1882.	Dana Coe, Burke.....	89.0
1883.	" ".....	74.0

ANALYSES OF MILLING BY-PRODUCTS.

Station Number.	Material.	Manufactured by	Sample Received From	Retail selling Price.
1474	Cream Gluten Meal	Charles Pope & Co., Geneva, Ill.	W. E. Dennis, Boston	\$25 00
1478	Corn Germ Feed	Charles Pope & Co., Geneva, Ill.	W. E. Dennis, Boston	18 00
66	Buffalo Gluten Feed	American Glucose Company	Chas. M. Cox & Co., Boston	22 00
178	Ground Wheat Screenings		L. J. Sanderson, Highgate	
179	Dairy Middlings		L. J. Sanderson, Highgate	
180	Chicago Gluten Meal	Chicago Sugar Refining Co., Chicago, Ill.	Burlington Flouring Co., Burlington	25 50
181	Chicago Maize Feed	Chicago Sugar Refining Co., Chicago, Ill.	Burlington Flouring Co., Burlington	21 50
182	Cleveland Concentrated Meal	Cleveland Linseed Meal Co., Cleveland, Ohio	E. L. Bass, West Randolph	28 00
183	Cleveland Standard Dairy Feed	Cleveland Linseed Meal Co., Cleveland, Ohio	E. L. Bass, West Randolph	28 00

ANALYSES OF MILLING BY-PRODUCTS,

Station Number.	Material	Water.	Crude Ash.	Crude Protein.	Crude Fibre.	Nitrogen-Free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.	Nutritive Ratio.
1474	Cream Gluten Meal.....	8.09	1.21	38.40	3.94	32.81	16.15	6.14	0.36	0.20	1:2
1478	Corn Germ Feed.....	7.80	0.98	12.19	14.43	49.32	15.28	1.95	0.18	0.43	1:3.4
66	Buffalo Gluten Feed.....	7.83	0.98	21.81	6.65	52.78	9.95	3.49	0.22	0.19	1:3.9
178	Ground Wheat Screenings.....	8.60	2.93	14.72	4.54	66.13	3.08	2.86	0.66	0.78	1:5.6
179	Dairy Middlings.....	8.80	2.74	17.94	1.78	64.86	3.88	2.87	0.64	0.63	1:4.6
180	Chicago Gluten Meal.....	11.09	1.20	35.07	0.65	39.92	6.85	5.61	0.56	0.03	1:1.9
181	Chicago Maize Feed.....	8.99	1.06	22.30	6.85	52.91	7.89	3.57	0.43	0.05	1:4.1
182	Cleveland Concentrated Meal.....	10.66	4.40	25.51	6.83	46.28	6.32	4.08	0.68	1.03	1:3.1
183	Cleveland Standard Dairy Feed.....	10.98	5.56	26.47	8.77	42.95	5.37	4.24	0.68	1.24	1:2.8

THE RESULTS OF FERTILIZER INSPECTION IN VERMONT FROM 1885 TO 1893, INCLUSIVE.

The State Legislature of 1882 passed an act commonly known as the "Vermont Fertilizer Law," which was amended by the Legislature of 1884. The Legislature of 1888 replaced it by a law similar in substance, but differing in detail, and it is now essentially the same as is found upon the statute books of most of the States. It provides, among other things, that "the director [of the Vermont Agricultural Experiment Station] shall cause one analysis or more of each fertilizer or material used for manurial purposes [offered or exposed for sale in the State of Vermont, the retail price of which is ten dollars or more per ton], to be made annually and the results published."

Under this act this Station has analysed the commercial fertilizers sold in the State yearly since 1886. A compilation of the results of this yearly inspection will serve to show the condition of the fertilizer trade in the State during these years. The results of 1885 are also used, because the director of the Station, then State chemist, did the work and the data is at hand, and the figures of 1893 are added to complete the comparison to the date of writing.

During these nine years, twenty-one firms have offered the Vermont farmer over seventy-five brands of fertilizers, and there have been two hundred and ninety-six samples analyzed in the course of the regular inspection work, calling for over four thousand separate laboratory determinations.

During this time the average selling prices have fallen from \$37.90 to \$32.32 per ton, there being some decrease each year. This has been due mainly to competition and to the fall in the market prices of materials containing nitrogen and phosphoric acid. Nitrogen, in the better kinds of crude stock, cost 18 cents a pound in 1885, may be bought now as nitrate at 15½ cents, and has been as low as 14½ cents a pound. Soluble phosphoric acid has fallen in price in the same time from 9 to 6½ cents, and reverted from 8 to 6 cents per pound, insoluble phosphoric acid remaining unchanged, and potash advancing from 4½ to 4¼ cents per pound.

A schedule of the valuations of each year follows. They are those agreed upon each spring by the Experiment Stations of Massachusetts, Connecticut and New Jersey, after a careful study of prices ruling in the large markets of New England and the Middle States.

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND
CHEMICALS, 1885 to 1898.

The prices are in cents per pound.

	'85	'86	'87	'88	'89	'90	'91	'92	'98
Nitrogen in Ammonia Salts.....	18	18½	17½	17½	19	17	18½	17½	17
“ Nitrates.....	18	18½	16	16	17	14½	14½	15	15½
Organic Nitrogen in dried and ground fish, blood and meat.....	18	17	17½	16½	19	17	15½	16	17½
Organic Nitrogen in cottonseed and cas- tor pomace.....	18	17	17½	16½	15	15	15	15	16½
Organic Nitrogen in fine ground bone and tankage.....	18	17	16	16½	16½	16½	15	15	15
Organic Nitrogen in fine medium bone and tankage.....	18	15	14	13	13	13	12	12	12
Organic Nitrogen in medium bone and tankage.....	14	13	12	10½	10½	10½	9½	9½	9
Organic matter in coarse bone and tank- age.....	12	11	10	8½	8½	8½	7½	7½	7
Organic Nitrogen in horn shavings, hair and fish scrap.....	10	9	8	8	8	8	7	7	7
Phosphoric Acid soluble in water.....	9	8	8	8	8	8	8	7½	6½
Phosphoric Acid soluble in Ammo.citrate*	8	7½	7½	7½	7½	7½	7½	7	6
Phosphoric Acid in dry fine ground fish and in fine bone and tankage.....	6	7	7	7	7	7	7	7	6
Phosphoric Acid in fine medium bone and tankage.....	5½	6	6	6	6	6	5½	5½	5
Phosphoric Acid in medium bone and tankage.....	5	5	5	5	5	5	4½	4½	4
Phosphoric Acid in coarse bone and tank- age.....	4	3	4	4	4	4	3	3	3
Phosphoric Acid in fine ground rock phos- phate.....	2	2	2	2	2	2	2	2	2
Potash as high grade sulphate.....	7½	5½	5½	5½	6	6	5½	5½	5½
Potash as kainite.....	4½	4½	4½	4½	4½	4½	4½	4½	4½
Potash as muriate.....	4½	4½	4½	4½	4½	4½	4½	4½	4½

*Dissolved from 3 grams of the unground phosphate previously extracted with pure water by 100 c.c. neutral solution of ammonium citrate sp. gr. 1.09 in 30 minutes at 65° C. with agitation once in five minutes. Commonly called "reverted" or "backgone" phosphoric acid.

The above trade values are the average figures at which in the six months preceding March 1st of each year, the respective ingredients could be bought at retail for cash in the larger markets, in the *raw materials*, unmixed. They also correspond to the average wholesale prices for six months ending March 1st of each year, plus about 20 per cent in the case of goods for which we have wholesale quotations. The valuations obtained by the use of the above figures will be found to agree fairly with the reasonable retail price at the large markets of standard raw materials, such as Sulphate of Ammonia, Nitrate of Soda, Muriate of Potash, Sulphate of Potash, Dried Blood, Plain Superphosphate, Azotin, Dry Ground Fish, Ammonite, Castor Pomace, Bone and Tankage, and Ground South Carolina Rock.

The valuation of a fertilizer is obtained by multiplying the percentage of the several ingredients by 20, (which gives the pounds per ton) and these products by the price per pound.

These estimated values do not represent the proper selling prices of mixed goods at the point of consumption, during these years, but the prices at which a pound of nitrogen, phosphoric acid or potash, in their various forms, might have been bought for cash at retail in our large markets. They do not include the charges for transportation, storage, mixing, commissions, credit, etc., but are the prices of these ingredients ready for use purchased under the above named conditions, singly and not mixed. They stand in no direct or necessary relation to the comparative profits which may be derived from the use of various fertilizers by individual farmers. These values have an almost purely commercial significance, and are not designed to point out to a farmer whether he shall use potash, which is a comparatively cheap ingredient, or nitrogen, which is comparatively costly.

For further information concerning fertilizer analyses, and for an explanation of the meaning of the terms employed, the reader is referred to the previous reports and bulletins of the Station.

Two ways may be used in calculating the average composition of the goods sold in the State. The analyses of those brands sold each and every year may be used, excluding others, or the analyses of all brands may be averaged. Neither will give the absolute average, for they give the same power in the result to a brand that is sold in small quantities as to one sold in large quantities. It is impossible to state the absolute average in the absence of data showing the consumption of each brand.

There are usually from thirty-five to forty brands of goods sold each year in the State. They are never the same each year, old brands dropping out and new ones appearing, the change being sometimes one of name only. Of the seventy-five brands analyzed since 1885, but seven have been found every year. They may be considered the standard brands of the State, and it is probably safe to say that more than half the gross amount of sales in the State have been from these goods. They are Bowker's Hill and Drill Phosphate, Bowker's Stockbridge Potato Manure, Bradley's XL Superphosphate of Lime, Crocker's Buffalo Potato, Hop and Tobacco Phosphate, Cumberland Superphosphate, Quinnipiac Phosphate, and Quinnipiac Potato Manure.

The averages of analyses, selling prices, valuations, percentages of increase of cost over valuation*, and valuations of all at 1885 and at 1898 trade values of these seven brands are shown in the following table. Similar data averaging all brands analyzed each year, whether a standard brand or a new-comer, are shown in the table succeeding.

*The percentage of increase of cost over valuation. Example—1885 Standard Brands cost \$39.41, valuation \$28.97; \$39.41—\$28.97=\$10.43, \$10.43÷\$28.97=36 per cent, i. e. \$10.43 is the increase of the cost over the valuation, and 36 is the percentage of the same.

AVERAGE ANALYSES OF STANDARD BRANDS.

	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.
Nitrogen	2.82	2.86	3.37	3.19	2.97	2.78	2.78	2.79	2.85
Soluble Phosphoric Acid..	6.50	6.63	6.36	6.36	6.51	5.85	6.03	5.79	6.33
Reverted " " ..	1.95	2.12	2.46	3.56	3.63	3.98	3.57	2.85	2.91
Insoluble " " ..	1.64	1.69	2.02	2.05	1.92	2.54	1.96	2.25	2.19
Available " " ..	8.45	8.75	8.82	9.92	10.14	9.33	9.60	8.64	9.24
Total " " ..	10.09	10.44	10.84	11.97	12.06	11.87	11.56	10.89	11.43
Potash	3.54	3.31	3.24	3.48	3.37	3.33	3.57	3.20	3.14
Average selling price ...	\$ 39.40	\$ 38.57	\$ 38.28	\$ 36.50	\$ 36.14	\$ 35.43	\$ 34.00	\$ 34.29	\$ 34.00
Average valuation by each year's price	28.97	27.91	29.63	29.85	31.33	28.54	27.62	25.89	25.37
Per cent. increase of cost over valuation	36	38	30	22	15	24	23	35	34
Valuation by 1885 prices..	28.97	29.44	31.48	32.80	32.23	30.36	30.77	29.10	30.29
Valuation by 1893 prices..	24.50	24.81	26.73	27.67	27.02	25.47	25.83	24.49	25.37

The average compositions, selling prices and valuations of the standard brands are always higher than those of all the brands, and the percentage of increase of cost over valuation less in all but two years. This is caused by the presence of three potato fertilizers in the group of seven brands, they being richer in nitrogen and potash than most brands; and, also, by the presence of low-grade goods in the other table. The smaller percentage of increase of cost over valuation in the case of the standard brands, is an argument in favor of the wisdom of buying goods of an established reputation.

AVERAGE ANALYSES OF ALL BRANDS.

	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.
Nitrogen.....	2.88	2.58	2.75	2.80	2.55	2.41	2.52	2.42	2.41
Soluble Phosphoric Acid..	6.35	6.15	5.48	6.74	6.68	5.99	6.47	6.47	6.44
Reverted " " ..	1.93	1.92	3.23	2.80	2.97	2.97	2.86	2.60	2.84
Insoluble " " ..	2.13	2.59	2.52	2.56	2.98	2.71	2.00	2.18	2.34
Available " " ..	8.28	8.07	8.71	9.54	9.65	8.96	9.33	9.07	9.28
Total " " ..	10.41	10.66	11.23	12.10	12.63	11.67	11.33	11.25	11.62
Potash.....	2.77	2.69	2.84	3.12	2.69	3.16	3.13	2.82	2.64
Average selling price....	\$ 37.90	\$ 37.02	\$ 36.75	\$ 35.13	\$ 35.11	\$ 34.39	\$ 33.44	\$ 32.47	\$ 32.32
Average valuation by each year.....	26.72	25.75	27.15	28.96	29.05	26.70	26.07	24.48	23.53
Per cent increase of cost over valuation.....	42	44	35	21	21	29	27	33	37
Valuation by 1885 prices..	26.72	27.21	28.86	30.88	30.08	28.52	29.16	28.22	28.46
Valuation by 1893 prices..	22.25	22.79	24.19	25.75	24.79	23.71	24.23	23.41	23.53

Before the enactment of this law the fertilizer business of the State was in bad shape, high prices and inferior goods abounding. There were some arrant frauds sold in the State, like the Grafton Mineral Fertilizer and Stevens' Mineral Fertilizer, analyzed by Prof. Collier during the seventies. The former was two-fifths sand and three-fifths ground lime-stone rock; the latter was simply and solely sand. The best grade of goods sold in 1870, would have a value of \$16.34 at the prices of 1893. These inferior goods have been driven from the State, partly by their own worthlessness, partly by the workings of the law, as have, later, other no less barefaced frauds.

The percentage of increase of cost over valuation shows a marked decrease from 1885 to 1889, since which time it has increased again. During the last two years this increase has been rapid though not yet arriving at the wide margin of the early eighties. This decrease and increase is true of other States than Vermont, as may be seen by reference to the table below. It may be explained in part by the spurring effect upon the manufacturers of the establishment of Experiment Stations all over the United States in 1888, and the consolidation of firms and limiting of competition in 1892. It is probable, too, that about 20 per cent is the lowest margin possible to a solvent fertilizer trade, since the low margins of '88 and '89 were followed by the failure of several of the fertilizer firms selling in this State.

COMPARISON OF ANALYSIS AND GUARANTEE.

Manufacturers, moreover, are clinging closer to their lowest guarantees than formerly, as shown by the following table, which shows average compositions found and guaranteed in 1888 and 1893.

	NITROGEN.		PHOSPHORIC ACID.			POTASH.	
			Soluble.	Reverted.	Insoluble.	Available.	Total.
Found, 1888....	2.80	6.74	2.80	2.56	9.54	12.10	3.12
*Guar'nt'd, 1888	2.11	6.05	2.00	1.95	8.18	10.15	2.60
Found more than							
*Guaranteed..	0.69	0.69	0.80	0.61	1.86	1.95	0.52
Found, 1893....	2.41	6.44	2.84	2.34	9.28	11.62	2.64
Guar'nt'd, 1893.	2.04	6.38	2.18	1.44	8.55	9.90	2.52
Found more than							
Guaranteed..	0.37	0.06	0.66	0.90	0.73	1.72	0.12

The manufacturers in 1893 guaranteed a little less nitrogen and potash, and more available phosphoric acid than they did in 1888, and they gave much less of all ingredients. This brings guarantee and actual composition in 1893 quite close together.

It appears that the consumer of '88 and '89 was getting the best grade of goods and was paying a less excess over valuation than former or later buyers. But it does not follow that he was getting more plant food for the dollar invested than the buyer of 1893, for there has been a fall in the prices of mixed goods and a sharp fall in the trade values of fertilizing ingredients. The buyer of 1893 bought at the period of consumption for a dollar, 72.8 cents value in unmixed fertilizing ingredients at the seaboard; the buyer of 1888, 78.3 cents worth, and of 1885, but 58.7 cents worth, *based on the present (1893) trade values*. The plant food which cost a dollar in 1893, cost ninety-nine cents in 1888, and one dollar and twenty-four cents in 1885. It may be said that the Vermont consumer never paid less for his commercial fertilizers than in 1893. But if former prices were fair he should pay less now than ever before, because of the sharp fall in 1892-93 of the prices of crude phosphate stock. From 1889 to 1893 the average selling price has fallen \$2.79, or 8 per cent, the average valuation, \$5.52, or 19 per cent. In other words, the decrease in selling price has not been proportionate to the decrease in the actual cost of crude stock.

FERTILIZERS OF VERMONT AND CONNECTICUT COMPARED.

Does the consumer of commercial fertilizers in Vermont get as high a grade of goods and as cheaply as his neighbors in other States? It is not likely that the goods shipped into Vermont are inferior to those sent to New Hampshire or New York, which have only recently had fertilizer inspection, but they may be poorer than in Massachusetts and Connecticut, where inspection has lasted many years. The data in the following table have been calculated from Connecticut and Vermont reports:

*The irregularities in average guarantees of the various forms of phosphoric acid are due to contradictory guarantees.

REPORT OF THE CHEMIST.

	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.
Average Selling Price:									
Connecticut.....	\$39.61	37.71	37.42	36.05	36.23	35.64	36.09	35.37	—
Vermont.....	37.90	37.02	36.75	35.13	35.11	34.39	33.14	32.47	32.32

Connecticut more than Vermont	\$1.71	0.70	0.67	0.92	1.12	1.25	2.95	2.90	—
Connecticut % Excess in Selling Price.....	4.5	1.9	1.8	2.6	3.2	3.6	8.9	8.9	—

	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.
Average Valuation :									
Connecticut.....	32.15	30.13	29.74	30.07	30.77	29.30	29.09	28.17	—
Vermont.....	26.72	25.75	27.15	28.96	29.05	26.70	26.07	24.48	23.53

Connecticut more than Vermont	\$5.43	4.38	2.59	1.11	1.72	2.60	3.02	3.69	—
Connecticut % Excess in Valuation.....	20.3	17.	9.5	3.8	6.	9.7	11.6	15.	—

	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.
Per cent excess of cost over valuation :									
Connecticut....	23.2	25.2	25.8	19.9	17.7	21.6	24.1	25.6	—
Vermont.....	41.9	43.6	35.4	21.3	20.9	28.8	27.1	32.6	37.3

Vermont % Excess over Connecticut.....	18.7	18.4	9.6	1.4	3.2	7.2	8.	7.	—
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The Connecticut fertilizer control began in 1875, and there is no abrupt drop as in the case of Vermont from '86 to '88, yet we find the same period of small percentage excess of cost over valuation in '88 and '89 rising again later, as in Vermont.

The table shows:

1. That during these years the Connecticut consumer paid on the average \$1.52 more per ton for his goods, but
2. That owing to their higher grade, he received on the average \$3.07 worth more of plant food per ton, and consequently
3. Thirty dollars expended in Connecticut brought, on the average, as much plant food as thirty-two dollars did in Vermont.

These general statements are true not only for the average of these years, but for each year individually. The reasons for this state of affairs are many, among them being the greater gross tonnage of commercial fertilizers used in Connecticut, their different and better character, the sharper competition, the smaller cost of transportation, the long-continued fertilizer control, and finally and principally the demand of the consumer, based on long experience and intimate knowledge for a higher grade of goods.

THE FERTILIZER BUSINESS OF VERMONT.

A study of these facts, of the above table, and of the table showing the comparative values of the standard and of all brands, will tend to show that in the fertilizer trade, as in others, the best is usually the cheapest.

This situation has its most hopeful remedy in intelligent buying. The brands sold in the State are almost always equal or nearly equal to their minimum guarantees. It is no fraud in the eye of the law to charge a high price, so long as the guarantee is fulfilled. Other things being equal, the brand which gives the most available plant food for the dollar expended is the best. That there is a choice is evident from the results of inspection work in this State, and an intelligent study of market conditions, guarantees, selling prices and analyses, will go far towards aiding the consumer in his purchases.

It has been stated already that a dollar in 1893 bought as much plant food as \$1.24 in 1885. On the aggregate fertilizer business of the State, this amounts to a large sum. It means that the farmers of this State are saving \$50,000.00 yearly over what the same fertilizers would have cost in 1885. Many influences have combined to produce this result, and there is no doubt but that the work of the Station in sampling, analyzing and publishing the results broadcast over the State has been one of these influences, and by no means the least.

PIG FEEDING.

By W. W. COOKE.

The work in pig feeding at the Station during the past year has been a continuation of that of previous years, the general idea being to ascertain the best and most economical way of using the skimmilk from the dairy for the production of pork.

QUESTIONS ASKED.

1. Which is the better for young pigs, sweet skimmilk or sour skimmilk?
2. What is the best proportion of corn meal and skimmilk to be used in feeding young pigs?
3. What effect does the previous feeding have on the finishing off process?
4. How much skimmilk can profitably be used in this finishing off process?
5. What is the influence of feed on the amount of shrinkage in dressing?

ANSWERS RECEIVED.

1. Sour skimmilk produced just as good results, pound for pound, as sweet skimmilk. Where there was any difference it was in favor of the sour skimmilk.
2. Two ounces of corn meal to each quart of skimmilk has yielded the pound of pork at the least cost for food; a larger amount of corn meal has produced a more rapid growth, but at an increased cost for food for each pound of pork.
3. A method of feeding during the earlier months which tends to the development of bone, muscle and digestive organs, rather than the formation of fat, provides a foundation on which greater profit will be made when heavy feeding begins in preparation for market.
4. During the finishing off process, twelve quarts of skimmilk daily to each pig with all the corn meal that would be eaten, produced a more rapid growth and at less cost per pound than six quarts of milk under similar conditions.
5. Any method of feeding which furnishes bulky food tends to a larger growth of the stomach and intestines, and a larger per cent of shrinkage in dressing. Watery food has the same influence.

HISTORY.

The pigs used in the experiments were small Yorkshires and Berkshires, bought from L. S. Drew, Burlington. The test began May 23, when the pigs were about eight weeks old, and closed November 11. In order to get the pigs as nearly as possible into similar condition, they were all fed alike on nothing but skimmilk for the two weeks previous to May 23. During this time they got used to their surroundings, and especially to being kept each in a separate pen, so that at the beginning of the test proper, the four groups were of remarkable evenness.

The skimmilk used was part of the time from cold deep setting and partly from the separator. When from cold setting, that which was fed sweet was warmed before it was given to the pigs. The sour skimmilk was left in an open barrel and was not fed until it was thoroughly soured and loppered. The meal was not mixed with the milk until feeding time, so that sour skimmilk was fed with sweet corn meal. The Station conducted a similar test a year ago, and on the publication of the results, showing that the sour milk was equal in value to the sweet, the criticism was made and quite widely copied, that the corn meal being not mixed until feeding time, the test was not a fair one, and that the results are consequently not reliable. This criticism is foreign to the test and entirely mistakes its object and the lessons to be drawn from it. The idea is not a testing of the relative value of sweet and sour corn meal, but the value of sweet skimmilk as compared with sour skimmilk. What suggested the test was the advice given to creamerymen in many agricultural papers, to heat the skimmilk as soon as it came from the separator, and sterilize it so that it would keep sweet until fed. Many creameries have put in expensive apparatus for this purpose, and are daily putting themselves to a good deal of trouble and considerable expense to accomplish this object. The design of our test was to learn whether anything was gained by thus keeping the milk sweet. The figures obtained last year and during the present test speak for themselves, but the addition of corn meal to the sweet milk and then letting them sour together, would be something never done by the judicious farmer, and would defeat the object of the experiment.

In every case the pigs were fed all the skimmilk they would eat until they were taking six quarts each, daily. This amount was then kept constant and whatever more the pig could be induced to eat, was made up of wheat bran and corn meal in varying proportions.

One-half of the pigs had sweet skimmilk, and the others sour skimmilk. Four of the pigs had two ounces of corn meal mixed with each quart of milk, the other four had double this amount. During the finishing off process, part of the pigs kept the same amount of skimmilk, six quarts daily, that they had previously; the rest were given twelve quarts each, daily.

DAILY RATIONS OF THE PIGS.

GROUP I.

SWEET SKIMMILK.

PIGS 1 AND 6.

Corn Meal, 2 oz. to 1 qt.

Period.	Date.	Skim-milk. qts.	Corn Meal. oz.	*Bran and Corn Meal. oz.	Nutritive Ratio.
I {	May 23-June 8.....	3	6		2.55
	June 8-23.....	4½	9		
	June 23-July 3.....	6	12		
II {	July 3-11.....	7½	15		3.45
	July 11-23.....	6	12	18	
	July 23-Aug. 3.....	6	12	24	
	Aug. 3-23.....	6	12	30	
	Aug. 23-Sept. 3.....	6	12	36	
	Sept. 3-13.....	6	12	42	
III {	Sept. 13-23.....	6	12	42	3.90
	Sept. 23-Oct. 3.....	6	12	48	
	Oct. 3-13.....	6	12	54	

*Equal parts by weight.

GROUP II.

SOUR SKIMMILK.

PIGS 2 AND 7.

Feed same as that of Group I, except sour skimmilk instead of sweet skimmilk.

GROUP III.

SWEET SKIMMILK.

PIGS 3 AND 8.

Corn Meal, 4 oz. to 1 qt.

Period.	Date.	Skim-milk. qts.	Corn Meal. oz.	Bran and Corn Meal. oz.	Nutritive Ratio.
I {	May 23-June 8.....	3	12		3.25
	June 8-23.....	4½	18		
	June 23-July 3.....	6	24		
II {	July 3-11.....	7½	30		3.80
	July 11-23.....	6	24	12	
	July 23-Aug. 3.....	6	24	18	
	Aug. 3-23.....	6	24	24	
	Aug. 23-Sept. 3.....	6	24	30	
	Sept. 3-13.....	6	24	30	
III {	Sept. 13-23.....	6	24	30	4.10
	Sept. 23-Oct. 3.....	6	24	36	
	Oct. 3-13.....	6	24	42	

GROUP IV.

SOUR SKIMMILK.

PIGS 4 AND 9.*

Feed same as that of Group III, except sour skimmilk instead of sweet skimmilk.

GROUP V—FINISHING OFF WITH MUCH SKIM MILK.

PIGS 1, 2, 3 AND 4.

Period.	Date.	Skim- milk. qts.	Corn Meal. oz.	Nutritive Ratio.
IV.	October 13-19.....	12	45	3.85
	October 19-22.....	12	72	
	October 22-24.....	12	84	
	October 24-29.....	12	108	
V.	October 29—November 3.....	12	108	4.60
	November 3-11.....	12	120	

GROUP VI—FINISHING OFF WITH LITTLE SKIM MILK.

PIGS 6, 7, 8 AND 9.

Period.	Date.	Skim- milk. qts.	Corn Meal. oz.	Nutritive Ratio.
IV.	October 13-10.....	6	42	5.00
	October 19-22.....	6	66	
	October 22-24.....	6	78	
	October 24-29.....	6	102	
V.	October 29—November 3.....	6	102	5.75
	November 3-11.....	6	102	

*Pigs 1, 2, 3 and 4 were Berkshires. Pigs 6, 7, 8 and 9 were small Yorkshires.

GAIN IN LIVE WEIGHT.

	Pig No. 1.			Pig No. 2.			Pig No. 3.			Pig No. 4.		
Period.	Live Weight at Beginning of Period.	Live Weight at End of Period.	Gain in Live Weight During Period.	Live Weight at Beginning of Period.	Live Weight at End of Period.	Gain in Live Weight During Period.	Live Weight at Beginning of Period.	Live Weight at End of Period.	Gain in Live Weight During Period.	Live Weight at Beginning of Period.	Live Weight at End of Period.	Gain in Live Weight During Period.
I	30	56	26	28	55	27	30	62	32	29	60	31
II	56	156	100	55	157	102	62	163	101	60	159	99
III	156	202	46	157	199	42	163	207	44	159	202	43
IV	202	249	47	199	245	46	207	251	44	202	245	43
V	249	279	30	245	281	36	251	272	21	245	274	29

	Pig No. 6.			Pig No. 7.			Pig No. 8.			Pig No. 9.		
Period.	Live Weight at Beginning of Period.	Live Weight at End of Period.	Gain in Live Weight During Period.	Live Weight at Beginning of Period.	Live Weight at End of Period.	Gain in Live Weight During Period.	Live Weight at Beginning of Period.	Live Weight at End of Period.	Gain in Live Weight During Period.	Live Weight at Beginning of Period.	Live Weight at End of Period.	Gain in Live Weight During Period.
I	33	58	25	31	61	30	30	61	30	28	59	31
II	58	170	112	61	155	94	61	170	109	59	169	110
III	170	212	42	155	197	42	170	217	47	169	206	35
IV	212	251	39	197	237	40	217	255	38	206	241	35
V	251	267	16	237	267	30	255	260	5	241	257	16

LIVE AND DRESSED WEIGHTS.

No. of Pig.	Live Weight, Nov. 11. lbs.	Dressed Weight, Nov. 11. lbs.	Shrinkage in Dressing. lbs.	Per Cent of Shrinkage.
1	279	220	59	21
2	281	236	45	16
3	272	228	44	16
4	274	237	37	14
6	267	218	49	18
7	267	222	45	17
8	260	211	49	19
9	257	221	36	11
Average ..	270	224	45.5	16.5

SWEET SKIMMILK *vs.* SOUR SKIMMILK.

For the purpose of comparing the feeding value of sweet skimmilk and sour skimmilk, the groups I and III may be compared with groups II and IV, since the total grain fed was the same in each. The four pigs on sweet milk gained during the growing period, from May 23 to October 13, 172, 177, 179 and 187 pounds, respectively, a total of 715 pounds. During the same time the four pigs on sour milk gained 171, 173, 166 and 178 pounds, a total of 688 pounds. Thus in each case the pig on sweet milk has gained more than its mate on sour milk, an average of $3\frac{1}{4}$ and a total of 27 pounds. If the experiment had stopped here the verdict would have been decidedly in favor of sweet milk, but when the crowding for market began results were just reversed. During the finishing off process, from October 13 to November 11, the pigs on sweet milk gained 77, 65, 55 and 48 pounds, a total of 240 pounds; while the pigs on sour milk gained 82, 72, 70 and 51 pounds, a total of 275 pounds, and a gain over the pigs on sweet milk of 35 pounds.

It follows, then, that at the time of killing, the two sets of pigs had made substantially the same gain. A queer fact developed when the pigs were killed, and one for which no satisfactory explanation has been given. Each pig that had been fed sweet milk shrank more in dressing than its mate on sour milk. The per cents of shrinkage for the sweet milk pigs are, 21, 16, 18 and 19, an average of 18 per cent. The sour milk pigs shrank 16, 14, 17 and 11 per cent, an average of 14 per cent, or 4 per cent less than the pigs on sweet milk. This 4 per cent or about 8 pounds per pig, represents the total gain of the sour skimmilk over the sweet skimmilk.

This is much the same result as that obtained last year, when the same matter was investigated. The difference in the results obtained from feeding sweet skimmilk and sour are so little that not much can be claimed in favor of sour milk. Nor do we desire to claim any advantage from its use. The object of the experiment has been attained when it is shown, as these two years' work do show most conclusively, that sour skimmilk is at least equal in feeding value to sweet skimmilk.

Hence, farmers need not be afraid that they are losing money every time the milk sours on the way home from the creamery, and creamery-men need not go to any expense or trouble to so handle the skimmilk as to sterilize it and keep it sweet.

HEAVY VS. LIGHT FEEDING OF CORN MEAL.

Since an equal number of pigs on each side had sweet and sour skimmilk, we can omit this from consideration and compare Groups I and II directly with Groups III and IV. As they ate different amounts of food, it will be necessary to take into account the amount consumed and gain in weight, in order to ascertain which made the pork the more economically.

TOTAL FOOD EATEN FROM MAY 28 TO OCTOBER 18.

No. of Pig.	Skim-milk. qts.	Corn Meal. lbs.	Bran. lbs.	Total Dry Matter. lbs.	Gain in Live Weight. lbs.	Dry Matter Eaten for one pound Gain in Live Weight. lbs.
1	859	223	115	490	172	2.85
2	859	223	115	490	171	2.87
6	859	223	115	490	179	2.74
7	859	223	115	490	166	2.95
Average	859	223	115	490	172	2.85
3	859	303	88	536	177	3.03
4	859	303	88	536	173	3.10
8	859	303	88	536	187	2.87
9	859	303	88	536	178	3.01
Average	859	303	88	536	179	3.00

The pigs that had the larger amount of corn meal gained the faster, but not enough more to offset the extra amount of feed. It required 3.00 pounds of dry matter of the food to make a pound of growth on the pigs that had four ounces of corn meal to each quart of milk, while the other pigs made an equal growth on 2.85 pounds of dry matter. The former gained 28 pounds more in weight and consumed 212 pounds more of grain; thus the extra gain would not half pay for the extra feed.

The comparison becomes still stronger if we follow these pigs through the heavy feeding that followed in fitting them for market. The four pigs that had had the smaller amount of corn meal, gained between October 18 and November 11, 284 pounds, while the other four on the same rations gained but 231 pounds, a further gain of 53 pounds in favor of the lighter feed. Those pigs that had the larger amount of corn meal shrank 32 pounds less than the other in dressing, but this is not enough to throw the advantage in their favor, and the final account stands with but seven pounds more of gain in weight as the product of 212 pounds excess of grain eaten.

The experiment shows then that the pigs gave better returns when fed two ounces of corn meal to each quart of skim milk, than when given four ounces of meal to each quart of milk.

PROPER AMOUNT OF SKIM MILK FOR FINISHING OFF.

In all the previous feeding tests at the Station, during the finishing off process each pig has been given six quarts of skim milk daily. Many practical pig feeders throughout the State have expressed themselves as favoring a larger allowance, claiming that experience had shown them that much better results would be obtained thereby, and that if milk could not be obtained they added an equal amount of water, so as to make a liquid food of large bulk.

To test this point, when the finishing off process began, four of the pigs were kept on the six quarts of milk daily and the other four were given twelve quarts each. Each pig was crowded in addition with all the grain he would eat. The results are as follows :

No. of Pig.	Total Food Eaten from October 13 to November 11.			Gain in Live Weight.	Dry Matter Eaten for one pound Gain in Live Weight.
	Skim milk. qts.	Corn Meal. lbs.	Total Dry Matter. lbs.		
1	348	168	222	77	2.88
2	348	168	222	82	2.71
3	348	168	222	65	3.42
4	348	168	222	72	3.09
Average	348	168	222	74	3.00
6	174	153	182	55	3.30
7	174	153	182	70	2.60
8	174	153	182	48	4.23
9	174	153	102	51	3.56
Average	174	153	182	55	3.30

The pigs that received the most skim milk not only gained the fastest, but they also required one-tenth less food for each pound of growth. The four pigs gained 296 pounds and ate 672 pounds of corn meal mixed with 1,392 quarts of skim milk. The other four took half as much skim milk and also less of the corn meal, eating but 612 pounds mixed with 696 quarts of skim milk, and gaining 219 pounds. The former therefore have an extra

gain of 77 pounds to their credit to offset the 696 quarts of milk and 60 pounds extra of corn meal that they ate. If the milk is worth 15c. per hundred pounds and the corn meal \$22.00 per ton, the food to produce this 60 pounds of gain cost but \$2.95, or 4½c. per pound, and it sold for 6c. a pound live weight. It is evident then that a larger amount of skimmilk enables the pig to consume also a larger amount of meal and make a cheaper and more rapid growth.

EFFECT OF PREVIOUS FEEDING ON THE RESULTS OF HEAVY FEEDING FOR MARKET.

A study of the figures already given shows that the pigs which had received the largest proportion of skimmilk and bran during the growing period were in the best condition to make good use of the larger amount of food given them during the finishing off process. Both milk and bran are rich in the elements that go to make up bone and muscle, and these pigs had evidently built up a better framework and stronger digestive apparatus, so that when the heavy feeding with corn meal began, whether it was accompanied by little or much skimmilk, they grew faster with less food and were able to carry their growth to a greater weight before it became unprofitable.

SHRINKAGE IN DRESSING.

As in all the pig feeding tests at the Station, the amount of shrinkage is small. It varies from 11 to 21 per cent and averages 16 per cent. This general small shrinkage is due no doubt to the large amount of grain fed the pigs, and to the fact that at no time, in their lives were they fed any coarse fodder or allowed to run on pasturage. Thus there was a tendency to keep the stomach and intestines small and hence make a small shrinkage. There are evidences that the differing rations fed during the experiments of this year have had an influence to vary the amount of shrinkage. The fact that each pig fed on sour skimmilk shrank less than its mate on sweet milk, has been already alluded to and is so far without explanation. A study of the figures also shows the pigs fed twelve quarts of milk during the finishing off process, shrank one per cent more than those that were kept on six quarts of milk. This would be the natural result of compelling the pig to consume larger quantities of liquid, and hence distend the stomach and other organs.

Those pigs that were fed four ounces of corn meal to each quart of milk, shrank two per cent less than those that had two ounces to the quart. This again is the natural result of having the food in a more concentrated form.

It is, therefore, not safe to judge two methods of feeding by the gains made in live weight. It is necessary to know how much this live weight will shrink when put on the market, before a correct conclusion can be drawn as to the relative results.

FINANCIAL RESULTS.

No. of Pig.	Feed.	Dry Matter in Food Eaten.	Total Gain in Dressed Weight.	Dry Matter in Food Eaten for each pound Increase in Dressed Weight.
		lbs.	lbs.	lbs.
1	Sweet milk; little meal, much milk ..	713	197	3.61
2	Sour milk; little meal, much milk....	713	213	3.34
3	Sweet milk; much meal, much milk....	759	203	3.73
4	Sour milk; much meal, much milk....	759	211	3.59
6	Sweet milk; little meal, little milk....	672	192	3.50
7	Sour milk; little meal, little milk....	672	196	3.42
8	Sweet milk; much meal, little milk....	718	196	3.66
9	Sour milk; much meal, little milk....	718	205	3.50
Average.....		716	202	3.56

The pork sold at seven cents per pound dressed weight. The corn meal that was fed cost \$22 per ton, and the bran \$17 per ton. To make the results comparable with those previously recorded, skim milk is assumed to be worth 15 cents per hundred pounds.

No of Pig.	Cost of Food Eaten for each pound In- crease in Dressed Weight.	Selling Price per Pound.	Gain per Pound.	Total Increase in Dressed Weight.	Total Gain.
	cents.	cents.	cents.	lbs.	
1	4.70	7.00	2.30	197	\$4 43
2	4.35	7.00	2.15	213	5 65
3	4.88	7.00	2.12	203	4 30
4	4.70	7.00	2.30	211	4 86
6	4.43	7.00	2.57	192	4 93
7	4.84	7.00	2.66	196	5 21
8	4.67	7.00	2.33	196	4 56
9	4.47	7.00	2.53	205	5 19
Average..	4.56	7.00	2.43	202	\$4 89

This lot of pigs did the best financially of any ever fed at the Station. This is due principally to the high price at which the pork was sold, enabling them to be kept longer and brought to larger size than would have been profitable at the prices received in former years. Each one of the eight pigs represents a different method of feeding. The combination of six quarts of sour skimmilk daily, with two ounces of corn meal mixed with each quart during the earlier months, and double this amount of milk with all the corn meal the pig would eat for the last few weeks, has given the most growth for the least feed, and the least cost of feed, for each pound of growth, or in other words, the greatest net profit. The same treatment during growth, and a continuation of a uniform amount of milk through life, has yielded the next best results, while the least profit and the largest amount of food for each pound of growth is shown by the pig that had sweet skimmilk mixed with four ounces of corn meal to each quart, followed by a liberal allowance of milk during preparation for market.

WHEN TO MARKET PIGS.

The financial results would have been better if the pigs had been marketed a little earlier. This is shown by a comparison of the results at the end of the fourth period with the cost of the growth made during the fifth period.

	Periods I to IV.	Period V.
Average weight at end of period.....lbs.	247	269
Average daily gain in live weight during period.....lbs.	1.87	1.70
Average amount of dry matter in food consumed daily during period.....lbs.	3.85	7.92
Average amount of dry matter in food consumed for each pound increase in live weight.....lbs.	2.81	4.65
Average cost of food consumed for each pound increase in live weight.....cts.	3.69	6.17
Selling price per pound, live weight.....cts.	6.00	6.00
Gain per pound increase in live weight.....cts.	2.31	
Loss per pound increase in live weight.....cts.		0.17

The pigs during the fifth period did not quite pay for their feed.

At the end of the experiment the pigs had averaged a gain of 1.40 pound in live weight daily, and had eaten on the average 3.01 pounds of dry matter in the food for each pound of growth. If the test had been stopped at the end of the fourth period, they would have averaged 1.87 pounds a day of growth, and have eaten 2.81 pounds of dry matter daily. This latter record would then have been the best ever attained at this Station, if indeed it is not the best on record for pigs carried to the average weight of these, i. e.

247 pounds. During our tests in 1889, the pigs required 2.79, and in 1891, 2.82 pounds of dry matter in the food for a pound of growth, but in both these cases the pigs were grown to but a live weight of 200 pounds, and further growth would have required a much larger amount of food.

FINANCIAL SUMMARY.

The pigs gave a gain over the cost of their feed. They increased in live weight 1918 pounds, which sold for \$112.91, while the food they ate cost \$73.68, a profit of \$39.23 using the same figures as above, of \$22 per ton for corn meal, \$17 per ton for wheat bran, and 15 cents per hundred pounds for skimmilk.

VALUE OF SKIMMILK.

In the above figures the skimmilk has been given an assumed value of 15 cents per hundred pounds. The only reason for keeping and feeding the pigs is to serve as a method of utilizing the skimmilk. It would be a proper method of accounting, to take out from the amount received for the pork, the cost of the grain fed, and consider the balance as what was received for the skimmilk. The pigs were sold for \$112.91, and they ate \$44.11 worth of grain, which leaves \$68.70 as the amount realized for the 19,712 pounds of skimmilk they ate. This would be equivalent to 35 cents per hundred pounds.

FERTILIZING VALUE OF FEED.

This has been alluded to many times, but will bear repeating. Skim-milk especially is very rich in plant food. It is worth about 11 cents per hundred pounds to pour out on the ground as a fertilizer in addition to its feeding value, which has been shown above to have been in this experiment 35 cents per hundred pound, making a total value of 46 cents. And yet at most creameries farmers are willing to sell it for less, even, than its fertilizing value.

COMPOSITION OF FEED IN POUNDS PER TON.

	Nitrogen.	Phosphoric Acid.	Potash.	Valuation.
Skimmilk	11.0	4.1	4.2	2.29
Corn Meal.....	29.0	12.8	8.0	6.04
Wheat Bran.....	49.7	60.7	31.3	13.42

The total fertilizing value of the food eaten by these eight pigs is \$38.09, from food costing \$73.68, the fertilizing value thus representing 51 per cent of the market value of the food.

REPORT OF THE BOTANIST.

L. R. JONES.

As in previous years, most of the investigations of this department have been on plant-diseases and their remedies. The most interesting and important results will be found in the report of the work upon Potato Blights and Oat Smut.

More time and attention than in former years has been given to the placing of the most important results of the work on plant diseases before the farmers. One Bulletin* and a Circular Letter** have been published, in addition to newspaper and personal correspondence and lectures before farmers' meetings.

Considerable time has been given to the collecting and preparing of specimens illustrating the diseases of certain garden vegetables. This collection now forms a part of the united exhibit of Experiment Stations at Chicago, and will be returned at the close of the World's Fair, to form part of our museum.

The following is a list of the subjects of this report in their order :

I. *Potato Diseases :*

- (a) A comparative test of fungicides for the Late Blight. (*Phytophthora infestans*, D. By.)
- (b) The new disease, or Early Blight, (*Macrosporium Solani*, E. & M.?)
- (c) The Scab.

II. *Oat Smut :*

- (a) Experiments with remedies for Oat Smut.
- (b) Investigations as to the losses from Oat Smut in Vermont.

III. *Orchard Diseases :*

- (a) Experimental work in Spraying for Apple Scab.
- (b) A Leaf-Spot Disease of Apples. (*Phyllosticta pirina*, Sacc.)
- (c) Apple-Rust and Cedar-Apples. (*Roestelia pirata*, Thaxter.)

IV. *A Cucumber Spot Disease.* (*Cladosporium cucumerinum*, E. & A.)

V. *Green-house Diseases.*

- (a) Lettuce Rots.
- (b) Oedema of the Tomato.

*No. 28. See abstract on p. 24.

**On Potato Blights.

I. POTATO DISEASES.

(a) A COMPARATIVE TEST OF FUNGICIDES FOR THE LATE BLIGHT AND ROT.

(Phytophthora infestans, D. By.)

Experiments in previous years have shown beyond question the value of the Bordeaux mixture as a remedy for this potato disease. This fungicide being, however, one of the most inconvenient of the copper mixtures, we were led in 1891 to test some of the other copper salts in the hope of finding a substitute for it. The results of that work,* though not conclusive, were all in favor of the Bordeaux mixture. We felt that the importance of this work was such that we made it the chief problem in our experiments this last summer, (1892).

For the test we selected twelve of the most promising fungicides, including three strengths of Bordeaux mixture.

The tests were made in three fields. Field A, was planted May 20, to "White Star" potatoes; Field C was planted at about the same date with mixed seed, mostly "Early Rose;" Field B was planted to four varieties of potatoes, "Garfield," "Polaris," "Mrs. Foraker," and "Early Rose," very late, June 12, in order to be sure to escape the complication of the "new" disease with the *Phytophthora*, which interfered with experiments the year before.† The *Phytophthora* came early enough this time, however, to avoid this trouble.

Since the results in Field B were in all respects in accord with those in Field A, we will, for the sake of simplicity, base most of our statements upon the results from Field A, citing the results from Field B only as may be desirable for confirmatory evidence. In Field C only one application was made, the result of which is considered by itself on page 64.

FIELD A.

During June and July, dressings of Paris green for the beetles were applied as necessary. July 30th, all parts of the field were alike in healthy condition. Sixteen plots were then staked out, two rows in each plot, thirty-three hills in each row. The rows ran north and south. Twelve of these plots were then sprayed as follows, five plots being left untreated as checks :

1. Untreated.
2. Copper Soda Solution—8 lbs. copper sulphate, 12½ lbs. sal soda, 50 gals. water.
3. Verdigris Solution—5 lbs. verdigris, 50 gals. water (reduced one-half after first application).
4. Bordeaux Mixture and Molasses—8 lbs. copper sulphate, 8 lbs. lime, 8 lbs. molasses, 50 gals. water.

*See Rep. Vt. Exp. Sta. 1891, p. 130.

†Rep. Vt. Exp. Sta. 1891, p. 131.

5. Ammonical Copper Carbonate—5 oz. copper carbonate, 3 pints strong ammonia, 45 gals. water.
6. Untreated.
7. Strong Bordeaux Mixture—6 lbs. copper sulphate, 4 lbs. lime, 22 gals. water.
8. Weak Bordeaux Mixture—5 lbs. copper sulphate, 5 lbs. lime, 50 gals. water.
9. Very Weak Bordeaux Mixture—1 lb. copper sulphate, 1 lb. lime, 30 gals. water.
10. Copper and Ammonium Carbonates—1 lb. copper carbonate, 2 lbs. ammonium carbonate, 50 gals. water.
- 11a. Untreated.
Several rows here omitted on account of low ground.
- 11b. Untreated.
12. Glue Mixture—10 oz. copper sulphate, 12 oz. sal soda, 8 oz. liquid glue, 25 gals. water.
13. Modified Eau Celeste—4 lbs. copper sulphate, 5 lbs. sal soda, 3 pints ammonia, 45 gals. water.
14. Copper Carbonate in Suspension—1 lb. copper carbonate (precipitated), 25 gals. water.
15. Copper Chloride Solution—3 oz. copper chloride, 22 gals. water.
16. Untreated.

The weather for the next three weeks was quite rainy. August 10th the first of the *Phytophthora* was found, only a few leaves on Plot 1. It continued warm and rainy during this night, and the next day. August 12th, the disease was found on every untreated plot (Plot 1, 6, 11a, 11b, 16), but not a single blighting leaf could be found on any one of the sprayed plots, excepting the plot sprayed with Ammoniacal Copper Carbonate (Plot 5), where several hills showed the disease badly. August 13th, a second application of all the mixtures was made of the same strengths as the first, except on Plot 3, where the Verdigris solution was reduced to half its former strength, owing to the evident injury to the foliage from the first application. August 25th a third application of all the fungicides was made similar to the second, except that ten hills in the middle of each row were left unsprayed.

Thus the middle third of each plot was left with only two applications, while the two outer thirds had three applications. This was done in order to test the relative gains from two and from three applications. At this time, practically all of the leaves on the untreated plots were dead, and the plots to which the weaker fungicides had been applied, were so badly diseased that this comparative test of the two and the three applications was of value only in the cases of the stronger fungicides, as shown in the table on page 63.

September 8th the following conditions were noted:

Plot 1. Every leaf dead and dry.

Plot 2. All dead except a few plants at one end.

Plot 3. Apparently this mixture equals the last as a fungicide, but the leaves not attacked by the blight are badly burned by the mixture.

Plot 4. In fine condition, scarcely a diseased leaf on entire plot.

Plot 5. Every leaf dead and dry.

Plot 6. Every leaf dead and dry.

Plot 7. Entirely free from disease, though owing to soil, not quite so thrifty as Plot 4.

Plot 8. Nearly equal to Plot 7, though not quite.

Plot 9. About half the foliage dead.

Plot 10. Most of leaves dead. Not equal to 9.

Plot 11a. Every leaf dead and dry.

Plot 11b. Every leaf dead and dry.

Plot 12. Nearly every leaf dead and dry.

Plot 13. Considerable blight, especially at one end.

Plot 14. Only a few green leaves left.

Plot 15. Every leaf dead except a few on two hills.

Plot 16. Every leaf dead and dry.

In order to show more clearly the conditions at this time, a number of photographs were made. Some of these are reproduced in Plates I, II and III. Plate I shows a single hill from each plot, selected as a sample of that plot. Plates II and III show Plots 4, 5, 6 and 7, entire, with their respective yields, as photographed later, shown above them. A study of these plates will give some idea of the striking contrasts between some of the plots at this time, especially Plots 4, 5, 6 and 7.

When dug, the difference in yields was no less striking than this difference in appearance of the tops. Owing to the rainy weather of July and August, the varying conditions of the plots, as to surface drainage, make comparisons of yields of rows much separated, misleading. These differences would not have amounted to so much in a dry season, but during the very rainy weather of August, water stood much of the time between the rows in some portions of the field. This, of course, prevented the normal growth of tubers in these lower places, and also led to more loss from rot.

Plots 8 and 9 were in the lowest portion of the field, and suffered most from this standing water, their yields as shown in the accompanying table being less than that of Plot 10, although as shown by the condition of the foliage and also by the weight of rotten tubers the fungicides on both 8 and 9 were superior to that on 10. Plots 1 to 4 may be fairly compared with each other, as may Plots 5 to 7, Plots 10 and 11a, and Plots 11b to 16. The larger yield of Plot 4, as compared with Plot 7, was not due to the superior fungicidal value of the molasses mixture used on Plot 4, as was

clearly shown by the condition of the foliage and the amount of rot, but was entirely due to soil conditions. The duplicate work in Field B. helped much in deciding such questions, as may be seen by the following table :

YIELDS FROM FIELD A.						YIELDS FROM FIELD B.
No. of Plot.	Fungicide Used.	Large Sound Tubers. Bu. per Acre.	Large Rotting Tubers. Bu. per Acre.	Small Sound Tubers. Bu. per Acre.	Small Rotting Tubers. Bu. per Acre.	Large Sound Tubers. Bu. per A.
1	None.....	184½	32	54½	5	44
2	Copper-Soda.....	299	34	42	8½	76
3	Verdigris.....	258½	5	63½	1½	98
4	Bord. M. & Molasses	354½	2½	46	½	161½
5	Am. Copper Carb....	105½	21½	38	8½	116
6	None.....	99½	24½	50½	6	85½
7	Strong Bord. Mix. .	291½	2	58	0	186½
8	Weak Bord. Mix. .	164	4½	66½	½	180½
9	Very Weak Bord.M.	189½	16	60	4½	119½
10	Cop. & Am. Carb....	171½	23½	41½	5½	116½
11a	None.....	114½	38	50	17½	123½
11b	None.....	232	7½	47½	1½	
12	Glue Mixture.....	258½	3½	40	½	172½
13	Mod. Eau Celeste...	291	1½	34½	½	242
14	Copper Carbonate...	256	½	27½	½	230
15	Copper Chloride....	186	5½	32½	½	170
16	None.....	207	19	42½	4	124

The yields in Field B, given in the last column above, may also prove misleading if the attempt be made to compare widely different plots, as for example, 7 and 13. If, however, the yields of adjacent check plots be taken into consideration, this matter is easily corrected. For example, Plot 13, when compared with checks 11 and 16, shows a gain of 95 per cent, while Plot 7, as compared with check 6, shows a gain of 119 per cent, indicating clearly the superiority of the fungicide used on Plot 7 to that used on Plot 13. The yields from Plot 1, and in less degree, Plot 2, were abnormally low from lying alongside a roadway at the margin of the field.

CONCLUSIONS AS TO THE RELATIVE VALUES OF THE TWELVE FUNGICIDES TESTED.

Judging from appearance of the plants in the two fields, and from the yields as given above, we would rank the various fungicides tested in the following order of merit :

Rank.	Treatment.	Plot No.	Remarks.
1	Strong Bordeaux Mixture.....	7	These four are the only ones of sufficient merit to recommend them for practical use.
2	Bordeaux Mixture and Molasses.....	4	
3	Weak Bordeaux Mixture.....	8	
4	Modified Eau Celeste.....	13	
5	Copper-Soda Solution.....	2	These were all beneficial, most of them to a profitable degree, but not to be ranked with the other four.
6	Verdigris.....	3	
7	Very weak Bordeaux Mixture.....	9	
8	Precipitated Copper Carbonate.....	14	
9	Copper and Ammonium Carb.....	10	
10	Glue Mixture.....	12	
11	Copper Chloride.....	15	
12	Ammoniacal Copper Carbonate.....	5	

The above conclusions answer, so far as the work of a single season can do it, the main question raised in this experiment. The Bordeaux mixtures have stood in all our tests without a rival in checking *Phytophthora*. The addition of molasses increased the value of the mixture little, if any, and we do not recommend it.* The most surprising outcome of our experiments has been the utter failure of the Ammoniacal Copper Carbonate. We believe, however, that our conclusion as to this solution will stand the test of further experiment as we had the same experience with it in 1891. In a dry season it would doubtless prove much better comparatively, but during dry weather there is nothing to fear from this disease—it is wet weather, protracted rains, that bring on the blight, and at such times the weaker fungicides are either washed away or so much diluted as to be of little protection. It is still an open question, in our mind, whether we can afford to use the weak Bordeaux mixture in preference to the strong. We think that the observing man will soon learn to suit the strength of mixture to his particular need. When the disease is especially threatening a stronger mixture is called for, but when the season is dryer and the application is merely a precautionary one, the weaker mixture can safely be used. Again the strength of the solution should bear some relation to the apparatus for applying. If that apparatus be supplied with good Vermorel nozzles and well-managed, then we can afford to use the strong mixture; if, however, it is applied with some coarser nozzle, or (as is done, and successfully too, in many potato fields in this State) with a watering pot, or with pail and brush-broom, then a weaker solution should be used in proportion as more liquid is thrown upon each leaf.

*The danger to bees from the addition of molasses or any sugar solution to a mixture containing Paris green, is worthy of consideration. The question was laid before the Vermont Bee Keeper's Association at their annual convention, Dec. 28, 1892. This Association, after discussing the question, passed the following resolution:

Resolved: "That we, as bee keepers, apprehend danger from the addition of sugar to poisonous solutions used in spraying potatoes."

WHAT WAS THE ACTUAL GAIN FROM SPRAYING.

This is the important practical question constantly asked. The table on the preceding page (page 60) shows conclusively that from the use of the better fungicides we realized gains of from 60 to 200 bushels and more per acre, amounting to from 25 per cent to nearly 200 per cent. As the possible gains are determined by the actual losses from the disease, and these losses varied in different parts of the same field, the average gain may be better gotten at from the following summary of the yields of the four plots in fields A and B, sprayed with the better fungicides as contrasted with those check plots which may fairly be compared with them. It will be seen that where there was doubt as to which check plot should be taken, we have always taken the one giving the larger yield, hence the average gain is underestimated rather than overestimated.

FIELD A.

Sprayed Plots.			Check Plots.	
No. 4. Bord. Mix. and Mol. . .	354½ bu. per acre.		No. 1. 184½ bu. per acre.	
No. 7. Strong Bord. Mix.	291½ "		No. 6. 99½ "	
No. 8. Weak Bord. Mix.	164 "		No. 6. 99½ "	
No. 13. Mod. Eau Celeste.	291 "		No. 11b. 232 "	
Average yields.		275 bu. per acre.	155 bu. per acre.	

Average gain : 120 bu. per acre — 78 per cent.

FIELD B.

Sprayed Plots.			Check Plots.	
No. 4. Bord. Mix. and Mol. . .	161½ bu. per acre.		No. 6. 85½ bu. per acre.	
No. 7. Strong Bord. Mix.	186½ "		No. 6. 85½ "	
No. 8. Weak Bord. Mix.	180½ "		No. 6-11. 104½ "	
No. 13. Mod. Eau Celeste.	242 "		No. 11-16. 124 "	
Average yields.		193 bu. per acre.	100 bu. per acre.	

Average gain : 98 bu. per acre — 93 per cent.

AVERAGES OF FIELDS A. AND B.

Sprayed, 239 bu. per acre ; Checks, 127 bu. per acre ; Gain 112 bu. per acre — 88 per cent.

Taking the averages for the three Bordeaux Mixtures in the two fields, we have :

FIELD A.		FIELD B.	
Sprayed.	Check.	Sprayed.	Check.
270 bu. per acre.	128 bu. per acre.	176 bu. per acre.	92 bu. per acre.
Gain : 142 bu. per acre—111 per cent.		Gain : 84 bu. per acre—91 per cent.	

Average of A and B: sprayed, 223 bu.; checks, 110; gain, 113 bu.—103 per cent.

RELATIVE GAINS FROM TWO AND FROM THREE APPLICATIONS.

As stated on page 58, the middle third of each plot in Field A, was left with only the two applications made July 30th and August 13th, while the two outer thirds were given a third application August 25th. The value of this third application is evident from the following tabulated statement of the results:

Plot.	Fungicide.	I. Sprayed 3 Times.	II. Sprayed Twice.	III. Sprayed 3 Times.	Average I. & III.
4	Bord. Mixt. & Mol..	428½	265½	280	354½
5	Am. Cop. Carb.	128	86	82	105½
6	None	128	86½	75½	99½
7	Strong Bord. Mixt. ...	369½	157	213½	291½

Comparing these figures we find:

Averages of 4 and 7, where sprayed three times: 323½ bushels per acre.

Averages of 6 I and 6 III, checks on this last: 99½ bushels per acre.

Gain from three applications 224 bu. — 222 per cent.

Average of 4 and 7, where sprayed twice: 211 bushels per acre.

Yield of 6 II, check on this last: 86½ bushels per acre.

Gain from two applications: 124 bu. — 143 per cent.

The gain from the third application, therefore, was 79 per cent or a little over one-third of the total gain. The plants that received the third spraying lived considerably longer than those receiving only two applications.

These results should not be interpreted, however, as indicating that similar gain would result from a third application every year; that will depend, of course, upon the conditions of weather.

THE RESULTS IN FIELD C.

This was a piece of rather early potatoes, which was left with no treatment until August 15th, nearly a week after the first of the blight was seen. At this time the disease had gotten a pretty strong start. Fourteen plots were staked off, three were left as checks and to the other eleven fungicides were applied, the same as in the Fields A and B, except that Verdigris was dropped from the list. August 25th, when these plots were next examined, they were all badly diseased, and it was evident that even the strongest mixture had done but little good. In a few days more all were dead; when dug no appreciable gain was found from any of the treatments.

This experiment is especially significant when compared with results of a similar experiment in 1891. Then the blight came later and spread much more slowly, so that one field left until August 23d before spraying was preserved in good condition. (See Report 1892, p. 129.)

EXPENSE OF SPRAYING.

We are often asked how much does it cost per acre, chemicals and labor, to spray potatoes. We attempted an answer to this question last year in Bulletin 28. After another year's experience, we again give our opinion. It is impossible to give a general estimate that will suit all cases, as there are so many varying conditions. The amount of the mixture necessary to cover an acre will vary all the way from 50 to 300 gallons, according to the amount of foliage and the method of application. Where we have covered an acre with 50 gallons in the middle of July, we have used 100 and 150 gallons per acre on the same piece in August. Again, in the latter part of August, we have sprayed a poor piece of half-blighted plants with 100 gallons per acre, and on the same day, on another piece where the ground was covered with the mass of luxuriant leaves, we have found it necessary to use fully 250 gallons per acre. Again, as shown above, the number of applications varies with seasons. In 1891 a single application made August 20th, was sufficient on a piece of late potatoes, while in 1892 three applications were necessary. In general, we should plan for making three applications on all except very early or very late potatoes. These three applications will require from 200 to 500 gallons of the mixture, on the average 400 gallons used as follows:

100	gallons	per	acre	the	last	of	July.	
150	"	"	"	"	"	middle	of	August.
150	"	"	"	"	"	last	"	"

This estimate is for a field planted about May 15 to May 20, and which will yield 200 bushels per acre. In our work, it has taken (for three applications) about 2 gallons of mixture per bushel of yield. On early potatoes a fourth application may sometimes be necessary to keep off the Early Blight,* the first application being made the first week of July; in this case

*For discussion of this disease see page 66.

it will take about $2\frac{1}{2}$ gallons per bushel of yield. The mixture costs us about three-fourths of a cent per gallon as follows :

5 pounds blue vitriol at 7 cents.....	35 cents.
5 " lime " $\frac{1}{4}$ cent.....	$2\frac{1}{4}$ "

Total cost of 50 gallons weak mixture..... $37\frac{1}{4}$ cents.

As most potato growers have to pay a little more than this for blue vitriol, one cent per gallon is about the average cost. The cost of applying also varies much, depending upon luxuriance of growth of plants, and upon apparatus used. In our work, with a barrel-pump, three men and one horse have sprayed an acre well in two hours, when water was convenient, or at the rate of five acres a day, making the expense for labor about \$1.00 per acre. Others with similar apparatus, have said they could cover ten acres per day. We trust that some form of pump especially adapted for spraying potatoes will soon be placed on the market that will lessen this part of the expense.

SUMMARY OF COST OF SPRAYING ONE ACRE OF POTATOES.

Mixture for three applications—

	Minimum.	Maximum.	Average.
200 to 500 gallons at one cent per gallon....	\$2 00	\$5 00	\$4 00
Labor.....	1 50	3 75	3 00
	<u>\$3 50</u>	<u>\$8 75</u>	<u>\$7 00</u>

When we consider our gain of an average of 113 bushels per acre, worth last fall 80 cents per bushel, or \$90.40, the profit is great, even at the maximum expense. In our work during the past three years, in every case where we have used the mixture, the gain has been great enough, even when potatoes were at their lowest price, to much more than cover this maximum expense.

WHY IS THE YIELD INCREASED BY SPRAYING ?

No potato-grower who visited our potato-field last September doubted the advantages of spraying, yet when we present the figures which show how much our yield was increased by spraying we presume few farmers will be ready to believe that this doubling of their crop is a possible thing for them; or, to put it in another way, that they lost half of their possible potato crop last summer where they did not spray. Many potato-growers think that their chief loss from this disease is from the rotting of the tubers. As indicated in Bul. 28 (p. 22), the great loss from our potato blights is not from the rotting of the tubers, but from the premature death of the vines. This is clearly shown by the figures in the table of yields of Field A, on page 60. Take plots 6 and 7 for example :

Plot 6: Large sound $99\frac{1}{2}$ bu. per A.; large rotten $24\frac{1}{2}$ bu. per A.

Plot 7: Large sound $291\frac{1}{2}$ bu. per A.; large rotten 2 bu. per A.

By checking the rot then in Plot 7, we gained only 23 bushels. The total gain from the spraying was, however, 192 bushels per acre. Subtracting 23 bushels from 192 bushels leaves 169 bushels gained from checking the blight on the leaves, and thus prolonging the life of the vines from the middle of August, when the unsprayed plants died, to the latter part of September, when the sprayed vines ripened. The fact cannot be emphasized too strongly that even on the wettest portion of this field, where one-quarter of the tubers were rotten, this loss from rot was *only one-seventh* as much as was the loss from early death of the vines. *If every Potato-grower in Vermont could realize that his loss from rot last year, severe as it was, represented only one-eighth of his actual loss, it would arouse an interest in the value of fungicides as nothing yet has done.*

Each year we have studied this question we have become more convinced that few even of our observing potato-growers realize their loss from the premature death of the vines. We believe that could the facts be known, from experiments made in all the potato fields of the State similar to that in our own fields, it would be found that the potato crop of Vermont was reduced last summer fully one-third, from the premature death of the vines.

(b) THE NEW POTATO DISEASE OR EARLY BLIGHT.

In our last report (Rep. 1891, p. 131) a "new" * potato disease was mentioned. This trouble was still worse in 1892. Large numbers of specimens

*It is not at all certain that this disease is a new one. It is more probably a general recognition of an old trouble which has been confused with the *Phytophthora* blight. What appears to be the same trouble is common in many parts of the country and apparently has been for years, as may be seen from the following notes:

In Vermont, there has been a similar trouble since 1889, at least.

In Iowa, Prof. Pammel says it "has been common for several years."—Ia. Bul. 20, p. 719.

In Wisconsin, Prof. Goff describes a similar trouble and says, "How long it has prevailed in Wisconsin is not known, but it probably is not of recent introduction."—Wis. Bul. 34, p. 8.

In Canada, Prof. Fletcher reports this trouble common and destructive in Ottawa.—Rep. Exp. Farms 1892, p. 164.

In Delaware, Prof. Chester found this trouble serious in 1891 [Del. Bul. 15 p. 14], and writes of its presence in 1892.

In Massachusetts, Prof. Humphreys found it injurious in 1891, and also 1890 [Mass. Rep. 1891, p. 226], and wrote of its presence in 1892.

In Connecticut, Prof. Sturges noted serious blighting of potatoes from some unknown cause, not *Phytophthora*.—Conn. Rep. 1892, p. 41.

"Prof. Galloway writes that he finds *Macrosporium Solani* constantly associated with certain diseases of the potato."—Ia. Bul. 20. p. 719.

In this connection the following letter, just received from Dr. J. B. Ellis, of Newfield, N. J., will prove of interest:

"*Macrosporium Solani*, E. and M., was published in Am. Nat. Dec., 1882, p. 1003. In Gre-villa, Sept., 1883, p. 32, Cooke published the same thing under the same name, i. e., *Macrosporium Solani*, Cke., having probably overlooked our publication. Cooke found it on *Datura Stramonium*. It seems to me, as you say, that this thing may have been growing on potato leaves for a long while, but it has not been specially injurious until lately, when peculiar atmospheric conditions, or some other cause unknown, have caused it to grow more luxuriantly."

were sent to us for examination from various parts of the State. We are still in some doubt as to the cause of part of this trouble, and do not think that any one thing is wholly responsible. Leaves that had been attacked by insects seemed to suffer worst, many of the dead spots having at their center one or more of the holes eaten by the flea-beetles. Large numbers of leaves were sent to us that had evidently been killed by too much Paris green, some of them being literally coated with this poison. It may not be out of place to suggest that danger of killing the foliage from Paris green is lessened if a little fresh lime is added to the Paris green water.*

But neither Paris green nor insect injuries can account for all of the serious blighting of early potatoes throughout the State last summer. The trouble began to show about the middle of July, and by the first of August was general and serious. The leaves blackened and curled at the tips and edges first; or often spots appeared scattered over the leaf, which gradually enlarged and merged together. Owing to this slow progress the dead parts generally became dry and crisp, and often broke away leaving the leaf ragged.

In many leaves examined we were unable to find any trace of fungous attack. In the large majority, however, we found a *Macrosporium* apparently *Macrosporium Solani*, E. & M. Specimens were sent to Prof. B. T. Galloway, who pronounced it this species.

As no cultural experiments or inoculations were made, we cannot say with certainty that this *Macrosporium* is the cause of this disease,† yet the general association of this fungus with the disease leaves little doubt in our minds that it was the cause of a large part of the trouble last summer. Apparently insect punctures or other injuries to the leaf, offer a favorable starting point for this fungus.‡ The further fact should be noted that this

*"By the addition of a little lime to the mixture, London purple and Paris green may safely be applied at the rate of 1 pound to 125 to 150 gallons of water to the tenderest foliage, or in much greater strength to strong foliage, such as that of the apple" [or potato].—C. V. Riley, Farmer's Bul. No. 7, U. S. Dept. Agric.

"One of the best ways of doing this is to add three-fourths of a pound of lime to a pound of the London purple [or Paris green] and thoroughly mix them in a gallon of hot water, allowing the mixture to stand two hours and keeping it hot during this time if it can conveniently be done."—C. M. Weed, "Spraying Crops," p. 20.

†Prof. Chester of the Delaware Station, writing concerning a similar blight in that State, says, "from artificial infection with the spores of *Macrosporium Solani* there is little doubt that this is the true cause of the trouble. Del. Exp. Sta. Bul. IV.

‡See also circular letter issued from this Station Aug. 12, 1892.

Similar association of this disease with insect injuries is mentioned by Prof. Chester, Del. Bul. XV. p. 13; Prof. Fletcher of Canada, Rep. 1892, pp. 163-3; Prof. Goff, Wis. Bul. 84, p. 8.

disease does little damage until after the plants blossom and pass their stage of greatest vigor. Many potato growers were misled by this fact into believing that their potatoes merely "ripened off" unusually early last summer. The lightness of the yield and the appearance of the tubers show, however, that the vines died prematurely. Where we examined the tubers of these early potatoes, their appearance indicated immaturity, and in this opinion we have been confirmed by some of our best practical potato growers. We believe that few, if any, early potatoes in the State matured fully last summer, and, as explained on page 66, such premature death of the vines always means a serious shortening of the crop, aside from injury to its quality. Many potato-growers who realized that their plants were diseased attributed the trouble to the common or *Phytophthora* blight. In order to aid in distinguishing these diseases, we issued a circular Aug. 12th, 1892, describing the two. So far as we have learned, it served its purpose well.

Potato growers generally have used the terms "blight" and "rust" for any disease of the potato-leaves. In our descriptions we have found the terms "early blight" and "late blight" very helpful. It would be better if we could re-name these diseases to apply the name "potato-mildew" to the *Phytophthora* disease, and the name "leaf-spot disease" to the *Macrosporium*. An attempt to introduce these as popular names would, however, only lead to confusion. The terms "early blight" and "late blight" as we use them, also describe the diseases as they occur in Canada, according to Prof. Fletcher, and we think they will serve as well in all northern New England and New York, as in Vermont. Further South and West there appears to be little of the *Phytophthora* blight.

In our popular descriptions of the two diseases, we have emphasized the following points of difference:

1. *The dates* of the attack, already mentioned.
2. *The weather.* The early blight developing and spreading even in dry, cool weather, the late blight only in warm, moist weather.
3. *The rapidity of the spread.* The early blight slowly, the late blight very rapidly.

4. *The appearance.* In order to show more clearly the more striking differences in the appearance of the two diseases we have inserted two drawings Fig. 1 and Pl. IV. Fig. 1 is from a plate in the Report of U. S. Dept. Agric. for 1888, and shows the mode of attack of the *Phytophthora* or late blight. Plate IV shows a leaf attacked by the *Macrosporium* or early blight.

The *Phytophthora* or late blight appears on the leaf as a purplish, black spot, which rapidly increases in size until it spreads over the entire leaf. As shown in Fig. 1, the diseased spot may start anywhere upon the leaf, and once started it spreads so rapidly that the base of a leaf is often black and dead, while the tip is still green, not having had time to wilt.



- | | | |
|-------------------------------|----------------------------|--------------------------------|
| 1 Untreated. | 3 Verdigris Solution. | 4 Bordeaux Mixture & Molasses. |
| 5 Ammoniacal Copper Carb. | 7 Strong Bordeaux Mixture. | 8 Weak Bordeaux Mixture. |
| 9 Very weak Bordeaux Mixture. | 11 Untreated. | 12 Glue Mixture. |
| 13 Modified Eau Celeste. | 15 Copper Chloride. | 16 Untreated. |
| 2 Copper-Soda Solution. | | |
| 6 Untreated. | | |
| 10 Copper and Amm. Carb. | | |
| 14 Copper Carbonate. | | |



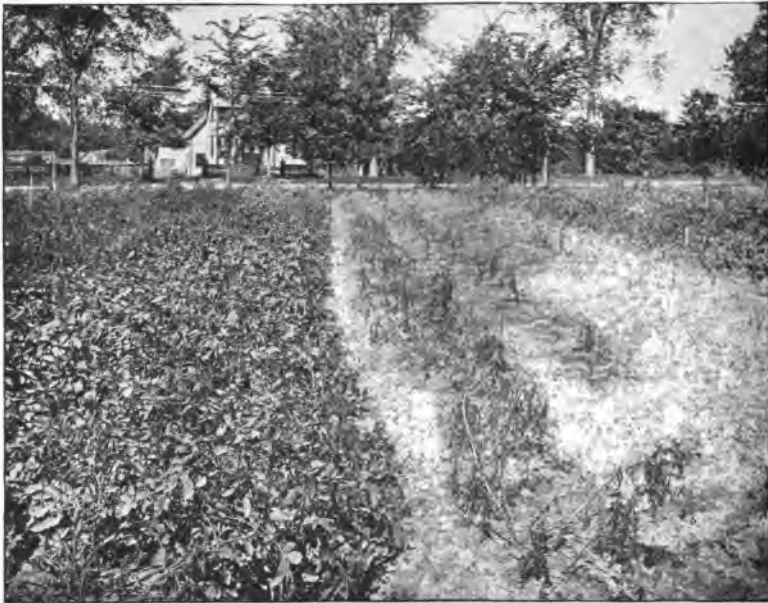
PLOT 4.

Total marketable tubers, 354½ bu. per acre.



PLOT 5.

Total marketable tubers, 105½ bu. per acre.



PLOT 4.

Bordeaux Mixture and Molasses.

PLOT 5.

Ammoniacal Copper Carbonate.



PLOT 7.

Total marketable tubers, ~~201~~ bu. per acre.
201



PLOT 6.

Total marketable tubers, 99½ bu. per acre.



PLOT 6.
Untreated.

PLOT 7.
Bordeaux Mixture.



THE EARLY BLIGHT OF POTATOES.

Macrosporium Solani, E. & M.

FIG. 1.



THE LATE BLIGHT OF POTATOES.

Phytophthora infestans, D. By.

This is the case in the lower right hand leaf of Fig. 1. For the same reason, if the disease appears at the tip of the leaf, as shown in the lower left hand leaf in Fig. 1, it may spread over the entire leaf before there is time for the natural drying and curling up of the dead portion.

The general appearance of the leaves attacked by the early blight is shown in Plate IV. In contrast with the single large spots of the late blight we have here many small spots scattered over the leaves, as shown on the lower leaves. These spots gradually enlarge and merge together, as shown on the upper leaves. The tips and edges of the leaf are especially attacked; as are also places where flea-beetles or other insects have mutilated the leaf. The progress of the early blight is comparatively slow. Owing to this slow progress and to the drier weather, the diseased portions of the leaf dry and become crisp as fast as they die, and the dead tips and edges of the leaves curl up, as shown in the upper leaves. No such mildew as occurs on leaves suffering from the late blight is ever found about these

dead spots, but a careful examination does show peculiar and characteristic marks. These are faint, thickened lines or rings in the dead spots, one ring outside the other, like the rings on a target board.

The two diseases may be contrasted as follows:

EARLY BLIGHT.

1. Apparently a "new disease" economically.

2. Attacks early potatoes. Worst in July.

3. Progresses slowly. Not checked by dry, cool weather.

4. Shows as several or many small dead spots (slowly enlarging and merging together later) scattered over the leaf. Leaf often dies at tip and edges first.

5. Owing to slow progress and dry weather the dead portions dry, crisp and curl up, especially at the tips and edges of the leaf.

6. Caused in part by the fungus, *Macrosporium Solani*.

7. Which causes peculiar "target board" markings in the dead spots.

8. Disease is confined to the tops. No rotting of the tubers.

9. The loss is therefore such as results from premature death of the vines.

10. Can probably be checked by applying Bordeaux Mixture three to five times, beginning (on early potatoes) early in July.

LATE BLIGHT.

1. Has been common for 50 years or more.

2. Attacks medium and late potatoes. Worst in August.

3. Progresses very rapidly, and only during the moist, warm weather.

4. Shows anywhere upon the leaf, generally as a single spot which rapidly spreads over the whole leaf.

5. Owing to the rapid progress and wet weather, the diseased leaf does not usually have time to dry and curl until the entire leaf is dead.

6. Caused by the fungus *Phytophthora infestans*.

7. Which can often be seen as a delicate frost-like mildew.

8. Disease passes from leaves to tubers, causing "rot."

9. The loss is therefore two-fold: (a) Premature death of vines. (b) Rotting of tubers.

10. Both blight of tops and rot of tubers can be prevented by two or three applications of Bordeaux Mixture, beginning generally the latter part of July.

In so far as this early blight is caused by the attacks of the *Macrosporium*, we may hope to hold it in check by spraying, as for the other blight except that we must begin earlier, the first to the middle of July on early potatoes. From the results so far obtained at other Stations, as well as in our own work, we do not think this early blight will succumb as readily to the Bordeaux Mixture as has the late blight. This is a matter which will be further tested at this Station, and doubtless at others, for the same disease seems to be general in this country and in Canada.

But even granting that we can check this early blight on our early potatoes, the number of applications and the consequent trouble and expense must be greater than that of checking the late blight on later planted potatoes. We believe therefore that for our main potato crop in Vermont the better way is to plant later, say the middle of May. We can thus largely if not entirely escape the early blight, and by spraying only two or three times in August we can secure a large crop free from blight or rot.

(c) POTATO SCAB.

A test was undertaken of several methods of treating seed potatoes for the prevention of Scab. The methods used were suggested by the results of the work of Professor Bolley of the N. Dakota Station (described in Vt. Bul. 28, p. 29), and of Prof. Kinney of the Rhode Island Station (R. I. Bul. 14). The seed used was all of the "White Star" variety, cut to two eyes. That used in Plots 1-4 was extremely scabby. The method of disinfection in plots 2, 3 and 4, was soaking $1\frac{1}{2}$ hours in 1:1000 corrosive sublimate solution. The ground prepared for the test was a clay sod which had been in grass for at least seven years. It was, however, open to the objection of having poor and uneven drainage, and sloped so that water might drain from one plot to another in many places. The unsatisfactory results of the experiment may in part be due to this.

The plan of the experiment with the results is shown in the table on the next page. These results evidently allow of no conclusions relative to the disease; they simply add another to the many perplexing outcomes of Scab experiments conducted on our long cultivated New England soils.

The results in the cases of plots 3 and 4 are of some interest, as showing that the tubers should be disinfected before cutting. The evil effects of disinfecting after cutting, are probably greater here than they would have been had more vigorous seed been used, the "scabby" seed being of low vitality anyway.

The amount of Scab in all parts of the field was surprisingly small, none of the tubers being so scabby as to make them unmarketable, whereas the scabby seed was from a field of which the entire crop was unmarketable because of the disease.

TABULATED RESULTS OF SOAB EXPERIMENT.

No. of Plot.	Kind of "Seed."	Treatment of Seed.	No. of Pieces Plant- ed.	No of Hills Dug	Per cent of the Pieces Planted that Grew.	Large Tubers Smooth.		Large Tubers Slightly Scabby.		No. of Small Tubers Smooth.	No. of Small Tubers Slightly Scabby.
						No.	Wt. lbs.	No.	Wt. lbs.		
1	Scabby.	None.	182	112	85	826	75½	85	9	198	25
2	"	Washed, then disinfected, then cut	127	115	90	250	68½	97	22½	102	28
3	"	Washed, then cut, then disinfected	182	52	40	127	45½	0	0	29	0
4	"	Cut, then disinfected (not washed)	182	98	70	262	78½	6	14	66	2
5	"	(a) Sprayed with Bordeaux Mix- ture in furrow.	66	64	97	154	40½	18	4½	42	8
6	Smooth.	(b) Soaked ½ hour in Bord. Mix. Placed manure in furrow, dropped "seed" on this, then sprayed as in 6a.	66	62	94	208	48½	7	1½	89	6
7	"	Untreated, check of 6.	182	115	87	827	81½	54	14½	99	15
			182	121	91	888	84½	85	19½	75	80

II. OAT SMUT.

- (a) A Further Experiment with Remedies.
 (b) Effect of Hot Water Treatment upon Germination and Yield.
 (c) Loss from Smut in Vermont, and Relation of this loss to the source of the Seed used.

(a) FURTHER EXPERIMENT WITH REMEDIES.

The tests begun last year* were continued during the present season. Two general methods of treatments were tried: the hot water treatment and soaking in solutions of potassium sulphide. Very smutty seed was used, as is evident from plots 1 and 11.

Plot.	Treatment of Seed.	Per cent of Smut in Crop.
1	Untreated.....	17.2
2	Soaked at 125° F. 5 minutes.....	5.6
3	" 128° F. 15 ".....	0.
4	" 130° F. 15 ".....	0.
5	" 133° F. 15 " then dipped in cold water.....	0.
6	" 133° 10 minutes.....	0.
7	" 138° 5 ".....	.6
8	" 143° 5 ".....	.8
9	" in 1 per cent Sol. Potassium Sulphide 12 hours.....	.65
10	" ½ " " " " 24 ".....	3.
11	Untreated.....	15.8

These results confirm those of last year, and agree with those obtained by all other experimenters as to the efficacy of the various hot water treatments. So far as their fungicidal value is concerned, either the longer treatment at the lower temperatures or the shorter time at high temperatures, gives practical freedom from smut. The small amount of smut found in plots 7 and 8, suggests that in these shorter treatments at high temperatures, care needs be taken to keep the grain stirred so that all is heated through.

The potassium sulphide treatments of plots 9 and 10 are those suggested in "Farmer's Bulletin No. 5," of the U. S. Department of Agriculture.

In this experiment, the ½ per cent solution 24 hours, did not prove effective, but the 1 per cent solution 12 hours, gave good results.

*Vt. Rep. 1891, p. 135.

(b) EFFECT OF THESE TREATMENTS UPON GERMINATION AND YIELD.

The possible benefits from the soaking of seed oats in hot water aside from the destruction of the smut spores, have been the subject of investigations, especially at the Kansas and Indiana Stations. Careful and repeated experiments there have led to the conclusion that there is an indirect gain in the yield, that is a gain over and above that due to the destruction of the visible smut. This gain has amounted to 10 per cent, and even more in some cases. The testing of this question was a matter of more interest to us last summer, than was the question of the fungicidal value of these treatments.

Two plots were carefully prepared for the test. The seed used was of "Canadian" stock that had been grown on the farm the year before, when it contained 8 per cent of smut. This season there was less than 2 per cent. of smut in the untreated, and none, of course, in the treated plots. The seed was sown with drill, 2 bushels per acre, April 23. Everything was favorable and a magnificent stand of grain was the result, until about the time it headed out, when it rusted badly and did not fill well. From germination until harvest there was no appreciable difference in favor of either treated or untreated plots, unless it was a very slightly thicker stand on the untreated. This, however, was hardly perceptible.

The arrangement of plots, treatments and yields were as follows :

SERIES A. EACH PLOT $10\frac{1}{2}$ x 276 FEET.

- | | |
|----------|--|
| Plot 1. | Untreated.
Yield, 111 lbs. grain, 205 lbs. straw and chaff. |
| Plot 2. | Soaked in water at 149° , 5 minutes, then dipped in cold water.
Yield, 104 lbs. grain, 241 lbs. straw and chaff. |
| Plot 3. | Soaked in water at 138° , 5 minutes.
Yield, 101 lbs. grain, 235 lbs. straw and chaff. |
| Plot 4. | Untreated.
Yield, 109 lbs. grain, 241 lbs. straw and chaff. |
| Plot 5. | Soaked in water at 133° , 10 minutes.
Yield, 101 lbs. grain, 279 lbs. straw and chaff. |
| Plot 6. | Soaked in water at 133° , 15 minutes, then dipped in cold water.
Yield, 94 lbs. grain, 252 lbs. straw and chaff. |
| Plot 7. | Untreated.
Yield 111 lbs. grain, 261 lbs. straw and chaff. |
| Plot 8. | Soaked in water at 143° , 5 minutes, then dipped in cold water.
Yield, 101 lbs. grain, 261 lbs. straw and chaff. |
| Plot 9. | Soaked in water at 138° , 5 minutes.
Yield, 108 lbs. grain, 247 lbs. straw and chaff. |
| Plot 10. | Soaked in water at 133° . 10 minutes.
Yield, 101 lbs. grain, 253 lbs. straw and chaff. |
| Plot 11. | Soaked in water at 133° , 15 minutes, then dipped in cold water.
Yield, 98 lbs. grain, 199 lbs. straw and chaff. |
| Plot 12. | Untreated.
Yield, 103 lbs. grain, 209 lbs. straw and chaff. |

SERIES B. EACH PLOT 6 X 150 FEET.

Plot 1.	Untreated. Yield, 37 lbs. grain, 144 lbs. straw and chaff.
Plot 2.	Soaked in water at 143°, 5 minutes, then dipped in cold water. Yield, 27 lbs. grain, 144 lbs. straw and chaff.
Plot 3.	Soaked in water at 138°, 5 minutes. Yield, 38 lbs. grain, 173 lbs. straw and chaff.
Plot 4.	Soaked in water at 133°, 15 minutes, then dipped in cold water. Yield, 35 lbs. grain, 150 lbs. straw and chaff.
Plot 5.	Soaked in water at 133°, 10 minutes. Yield, 26 lbs. grain, 141 lbs. straw and chaff.

We can find in these figures no evidence of great gain or loss from the treatments. So far as there is any difference, however, it shows a little more grain from the untreated plots and a little more straw from the treated plots. The following are the averages :

SERIES A.

Untreated : Grain, 108.2 lbs.
 Straw and chaff, 226.7 lbs.
Treated : Grain, 100.4 lbs.
 Straw and chaff, 232.2 lbs.

SERIES B.

Untreated : Grain, 37 lbs.
 Straw and chaff, 144 lbs.
Treated : Grain, 31 lbs.
 Straw and chaff, 152 lbs.

AVERAGE GAINS SERIES A AND B.

Grain, 10 per cent. more from untreated.
Straw and chaff, 3 per cent. more from treated.

These results do not agree with those of Dr. Kellerman, Dr. Arthur or Dr. Jensen. Since these men are all careful and experienced experimenters there can be no doubt as to the correctness of their conclusions, viz., that under the conditions of their experiments there was a marked increase of yield from the hot water treatment. This hot water treatment, in Dr. Arthur's experiments and likewise in our own, has hastened the

germination of the grain, even though it is thoroughly dried after the treatment and before planting. At the same time, in our own tests, it has lowered the per cent. of actual germination of the oats. But Dr. Arthur's (!) and Dr. Kellerman's (?) published results show this same fact. Dr. Arthur considers the action of the hot water in thus hastening germination and increasing the yield, to be due to the development of a ferment which "renders an unusual amount of starch available at the outset" (3). Dr. Kellerman advocates that part, at least, of the increased yield is due to the destruction of what he terms "concealed smut," or to the destruction of smut which, though it does not fully develop, yet injures the grain (4). We have found none of this "concealed smut" in our fields, and in a number of samples sent Dr. Kellerman, he found none of it. According to Dr. Kellerman's explanation, therefore, it would seem that we have no right to expect the same gain from the hot-water treatment that he found.

Granting that the per cent. of germination is lowered in the treated seed, then this must have some effect upon the yield. Experiments as to the amount of oats to be sown per acre at the Ohio and Indiana Stations, have shown that in general they get the maximum yield from about two bushels of seed per acre, sown by drill, and from about two and one-half bushels sown broadcast. More or less than this amount decreases the yield. On supposition that more than two and one-half bushels were sown per acre, the hot water treatment would tend to increase the yield merely from the fact that it lessens the per cent of germination; for the same reason if less than two bushels per acre were sown the hot water treatment would tend to lessen the yield. Opposed to this tendency in the latter case, and in co-operation with it in the former case, we have the beneficial effects of the hot water in increasing the solubility of the starch in the treated seed.

Again, it seems probable that the effect of the hot water in lowering germination is greater in some oats than in others. A marked difference in the effect of this treatment upon seed-corn, was noted in our tests in 1891 (See Ann. Rep. 1891, p. 140).

From our results, therefore, we feel compelled to doubt that the hot water treatment will in all cases increase the yields of oats, and to believe instead that in some cases it will actually decrease the yield.

(c) AMOUNT OF THE LOSS FROM OAT SMUT IN VERMONT AND THE RELATION OF THIS LOSS TO THE SOURCE OF THE SEED.

July 5, 1892, a copy of the following request was sent to each of one-hundred farmers in the State :

1. Agricultural Science, Sept. 1892.
2. Proc. A. A. A. S., 1892, p. 213.
3. " " " p. 227.
4. Kas. Exp. Sta. Bull. 15, p. 127.

STATE AGRICULTURAL EXPERIMENT STATION, }
BURLINGTON, VT., July 5, 1892. }

Dear Sir :—Since we now have a sure remedy for oat smut in the proper use of hot water for disinfecting the seed oats, it becomes a matter of importance to learn whether there is enough smut in the oat fields of the State generally, to make the use of this remedy profitable. Careful examination of an oat field almost invariably shows that there is more smut than is commonly supposed. Still it is a question whether there is enough smut as a rule to pay for the trouble of disinfecting the seed. In order to gain as much information as I can upon this point, I wish to get samples of grain from a large number of the oat fields of the State. These samples will be carefully examined, the relative amount of smut in each determined and a detailed report of the results made later. The result of so large a number of examinations cannot but prove instructive. Will you aid me in this work by sending samples from at least one oat field. If you can send samples from several different fields (that is fields sown with seed from different sources), I shall be very glad to receive them. In order to insure uniformity in method, as well as impartiality, the following directions are given for taking the samples :

1. The samples should be taken as soon as fully headed out.
2. As the disease is liable to be somewhat unevenly distributed at least five samples should be taken from each field.
3. That the samples may be of uniform size, take a heavy barrel hoop or make a frame about 2 feet square by tacking together four pieces of lath. In taking the samples drop this hoop or frame down over the grain and cut all of the plants enclosed by it close to the ground. Tie a string around each sample as soon as cut. Take five samples in this way from different portions of the field. Tie all into a bundle, wrap in several newspapers, or some old sacking, and send by express. A shipping tag properly addressed is enclosed.

If for any reason you cannot furnish the samples, will you kindly send me on the enclosed card the name of some one in your town who would, in your opinion, take the samples with proper care.

Yours sincerely,

L. R. JONES.

In reply to these requests, eighty-one samples were received, from as many oat fields. Upon examining these samples it was noticed that in most cases where the history of the seed was given there was more smut in grain from Western seed than in that from Vermont seed. In order to investigate this matter more fully, a second letter was sent to each one who sent samples, asking the source of the seed oats in the field from which the sample was taken. The results are interesting and instructive, as will be seen from the following summary. In order to show the results more clearly

the samples are arranged in the order of their smuttiness, and are placed in three tables, according to source of seed:

TABLE I—VERMONT SEED.

No.	Name.	Address.	Sound.	Smutty.	Per cent.	Remarks concerning seed.
75d	A. J. Hazen.....	Alburgh.....	566	38	6.29	From West 1868.
100	J. W. Wright.....	Pownal.....	267	15	5.62	From L. I. 1870.
96	E. R. Pember.....	Wells.....	439	20	4.35	Vt. grown for 20 years.
59	G. G. Hinsdale.....	St. George.....	477	16	3.24	" " " several years.
77c	F. G. Richardson.....	Brookfield.....	264	7	2.88	Same strain for 21 years.
75a	T. D. Jameson.....	Alburgh.....	445	10	2.19	Home grown several years.
6	W. Richmond.....	Newport.....	596	13	2.13	Same farm 20 years.
111	Lewis Talcott.....	Williston.....	346	7	1.98	Seed from Grand Isle Co.
77b	Monroe Wheatly.....	Brookfield.....	280	5	1.75	Vt grown for 10 yrs or more
13	Crosby Miller.....	Pomfret.....	133	2	1.48	From Dept. Ag. 12 yrs. ago.
72c	Benson Sanborn.....	S. Royalton.....	347	4	1.13	Home grown several years.
3	O. F. Stearns.....	Windham.....	305	3	.97	Vt grown seed 10 yrs or more
76b	H. J. Parker.....	Andover.....	320	3	.92	" " " great many yrs
	J. F. Hemenway.....	E. Chelsea.....	238	2	.83	Same town for years.
12	Cassius Peck.....	Brookfield.....	370	3	.79	Home grown over 20 years.
10 d	E. Stevens.....	Jonesville.....	382	3	.77	Vt grown for 6-8 yrs at least
75c	W. T. Sowles.....	Alburgh.....	419	3	.71	Same seed used grt many yrs
57	Henry Lawrence.....	St. George.....	299	2	.66	Vt. grown for long time.
72a	C. P. Stevens.....	Chelsea.....	453	3	.65	From West several yrs ago.
62c	J. W. Millards.....	Stamford.....	469	3	.64	Vermont seed.
93a	L. S. Chaffee.....	Troy.....	622	4	.64	" grown several yrs at least
4	E. R. Towle.....	Enosbgh Fls.....	556	3	.53	Same seed used for yrs.
54a	G. B. Brewster.....	Irasburgh.....	574	3	.52	" " " 20 yrs or more
63	W. H. Small.....	Morrisville.....	376	2	.52	Vt seed far back as can trace
54c	David Webster.....	Irasburgh.....	423	2	.48	Same seed used many years.
10b	B. S. Balch.....	Jonesville.....	233	1	.43	Home grwn 10-12 yrs at least
107	N. E. & J. Miller.....	Burlington.....	239	1	.42	Vt seed for several yrs at least
73	E. A. Edson.....	Chester.....	235	1	.41	Same seed several years.
70	Julius Morse.....	Cambridge.....	793	3	.38	Home grown grt. many yrs.
8	M. V. Willard.....	Jericho Cent.....	853	2	.36	Same seed used 10-12 years.
40	A. Messer.....	Rochester.....	807	1	.32	Vt grown several yrs at least
10c	Albert Town.....	Jonesville.....	322	1	.31	Vt seed, as far as can trace.
78	W. G. McAllister.....	Waitsfield.....	671	2	.29	From England 8 years ago.
69	A. M. Foster.....	Cabot.....	392	1	.25	Home grown grt. many yrs.
32	M. V. Clark.....	N. Williston.....	453	1	.22	Home grwn sevl yrs at least
54b	D. C. Carpenter.....	Irasburgh.....	586	1	.18	Vermont seed.
10a	S. Whitcomb.....	Jonesville.....	375	0	.00	Home grwn sevl yrs at least
39	P. K. Spaulding.....	Proctorsville.....	181	0	.00	Vt. seed as far as can trace.
44	L. W. Peet.....	Cornwall.....	386	0	.00	From U. S. Dep. 12 yrs ago.
72b	Milo Sanborn.....	Chelsea.....	354	0	.00	Vt. seed as far as can trace.
77	T. H. Wheatley.....	Brookfield.....	349	0	.00	Home grown seed.
84	D. R. Pierce.....	Waterville.....	309	0	.00	Seed raised in neigh-
84b	R. W. Leach.....	".....	157	0	.00	borhood as far back as
84c	Mr. Olin.....	".....	220	0	.00	can trace.
95	J. S. Wheeler.....	Waterbury.....	430	0	.00	Same seed 57 years. "No
		Center.....				change, No mixing."
104a	Mr. Kennedy.....	Underhill.....	168	0	.00	Vermont grown several
104b	M. Chapin.....	".....	166	0	.00	years at least.

Number of heads examined.....18,375.

Average per cent. of smut found.....1.00.

TABLE II. WESTERN SEED.

No.	Name.	Address.	Sound	Smut.	Per Cent.	Remarks.
65a	O. L. Miner	Brattleboro.	335	25	7.44	Western, from feed store.
65b	"	"	73	14	5.79	" " " "
6	E. B. True	Newport.	249	30	4.96	From West, 1891.
62II	Walter Brattan	Stamford.	492	20	4.07	Western, from feed store.
87	A. A. Storrs	E. Bethel.	656	27	3.93	Western, from E. W. Bailey, Montpelier.
91	G. S. Worcester	Thetford.	263	14	3.61	Western seed.
28	LeRoy Southw'ith	Middletown Springs	384	14	3.60	Western, from S. B. Curtis, Rutland.
1	Alonzo Emery	W. Rand'lph	375	14	3.59	From West, 1891.
64	G. H. Parker	Proctorsville	389	14	3.47	Western seed.
62I	Fred Foster	Stamford.	313	10	3.20	From West 2 years before.
75b	Lewis Furrier	Alburgh	524	15	2.96	Mixed Western seed.
76I	A. J. Parker	Andover.	235	7	2.89	Western seed, 4 years ago.
19	C. C. Forbes	Shoreham	948	26	2.66	Seed from Illinois, 1885.
27	J. C. Sherburne	N. Pomfret	873	19	2.13	Western, from grain dealer.
65c	O. L. Miner	Brattleboro.	72	1	1.40	" " " "
43	E. N. Cleveland	Franklin.	1048	8	.66	Seed from Ia., 1886.
104c	Mr. Hale	Underhill	152	1	.65	From West, 1890.
93II	L. S. Chaffee	Troy.	1059	6	.50	Western seed.
92	J. B. McLain	Topsham	394	2	.50	" "
74	J. E. Chamberlin	Bt. Landing	410	1	.24	" "
Number of heads examined					9,481	
Average per cent of smut found					3.13	

TABLE III. SEED FROM OTHER, OR FROM UNKNOWN SOURCES.

No.	Name.	Address.	Sound.	Smut.	Per Cent.	Remarks.
100	C. F. Johnson	Williston.	195	1	5.62	Source unknown.
108	Irving Whitcomb	"	1266	28	3.32	" "
9	C. C. Haynes	Wilmington	202	6	2.88	" "
110	John Whitcomb	Williston	349	12	2.00	" "
22	V. I. Spear	Braintree	400	8	1.98	From dealer, source unkn'n.
103	W. Houghton	Lyndon	668	6	.88	From Dep. Ag. 3 yrs. ago.
6	F. Wheelock	Derby	797	7	.87	From Manitoba 3 yrs. ago.
112	C. Miller & Sons	Williston.	572	4	.69	Source unknown.
106	C. F. Johnson	"	195	1	.51	" "
90	E. B. Batchelder	Townshend.	611	3	.50	" "
113	Samuel Bliss	Essex	514	2	.38	Source unknown.
79	E. A. Fitch	Wilmington	261	1	.34	From N. Y., 3 yrs. ago.
109	C. Caswell	Williston.	495	1	.20	Source unknown.
45	Dwight Sykes	Dorset	259	0	.0	From N. Y. 2 yrs. ago.
105	Harry Fay	N. Williston	457	0	.0	" " ?

Number of heads examined

7,321

Average per cent of smut found

1.34

From Tables I, II and III we have

<i>Total number of heads examined</i>	35,177
<i>Average per cent of smut found in all samples</i>	1.6

These results allow of two conclusions, the first of which may be overruled by further examinations and experiments; the second appears to be final. They are:

First—In general the loss from oat-smut in this State, where native seed is used, is not large enough to demand the use of the hot water or other treatment for disinfecting the seed.

Second—The average loss from oat-smut, where Western seed is used is much greater than where native seed is used, being in the samples examined over three times as great.

As stated in former publications, oat-smut is a disease propagated almost entirely in the seed-oats. The force of this last conclusion is therefore increased by a comparison of the amounts of smut found by Western investigators with that reported above. The loss from oat-smut as determined at the New York State¹ Experiment Station (1884-1886) was 9 per cent of the crop. In Kansas² (1888-91), the loss was placed at 10 per cent; in Indiana³ (1891), at 10 per cent; in Michigan⁴ (1891), 15 per cent; in Wisconsin⁵ (1891), the total loss is placed as greater than that of Michigan.

In view of these estimates the U. S. Dept. of Agriculture in a recent bulletin⁶ states that "the average loss is from 5 to 12 per cent in different localities in the United States," while Dr. J. C. Arthur,⁷ in a recent article states that this country loses annually from smut "nearly or quite 10 per cent of the total oat crop."

In order to satisfy ourselves as to the absence of any "concealed" smut which we might have overlooked in our examinations, we sent a number of the above samples to Dr. W. A. Kellerman of Columbus, Ohio, a recognized authority on oat-smuts, who after kindly examining them wrote: "I have carefully examined the bundles of oats sent me—over four thousand heads—and do not find any more smutted heads than you have found. I did not see any 'concealed' smut, though I handled each head separately and examined carefully."

In conclusion, it must be observed that the amount of smut in the same strain of oats, may vary considerably from year to year. Some facts would indicate that the amount of smut about Burlington was rather less in 1892

1, 3d An. Rep. N. Y. Ag. Exp. Sta. p. 332 and 5th Rep. same p. 124.

2, 2d An. Rep. Kas. Ag. Exp. Sta. p. 226.

3 Indiana Exp. Sta. Bul. 35, p. 81.

4 Mich. Exp. Sta. Bul. 87, p. 3.

5 Wis. Exp. Sta. Bul. 34, p. 4.

6 Farmers' Bul. 5, p. 4.

7 Agricultural Science, Sept., 1892.

than in 1891, yet we do not think the difference was very great. In order, therefore, to reach conclusions of permanent value as to the actual loss from smut, it is necessary to make such examinations for more than one year, and it is proposed to repeat this work the coming summer.

III. ORCHARD DISEASES.

(a) APPLE SCAB.

Some experimental work in checking apple-scab was undertaken. Owing, however, to the excessive rainfall of June and July the results were not satisfactory, as the increase of crop in the larger experiment was not sufficient to pay for the cost of the work.

In a small orchard near Burlington, two Fameuse trees were sprayed, and two standing beside them left as checks. The dates and applications were as follows:

May 8: Copper Sulphate Solution (1 lb. in 10 gals. water.)

June 15: Bordeaux Mixture (and Paris green), (5 lbs. Blue Vitriol, 5 lbs. lime, 50 gals. water.)

July 1: Ammoniacal Copper Carbonate (5 ozs. copper carbonate, 3 pints ammonia, 45 gals. water.)

July 25: Ammoniacal Copper Carbonate.

When picked the saleable apples were sorted into number ones and number twos, as follows:

Tree No. 1, Sprayed:—No. 1, 463 apples; wt. 55 lbs.

No. 2, 457 " " 54 "

Tree No. 2, Sprayed:—No. 1, 307 " " 38 "

No. 2, 411 " " 42 "

Tree No. 3 Check:—No. 1, 384 " " 55 "

No. 2, 696 " " 72 "

Tree No. 4, Check—No. 1, 280 " " 37 "

No. 2, 411 " " 44 "

These results may be more easily compared in the following form :

		NUMBER.		WEIGHT.	
			Per Cent.	lbs.	Per Cent.
Sprayed Trees.....	No. Ones...	770	47	93	49
" ".....	No. Twos...	868	53	96	51
Check Trees.....	No. Ones...	664	37½	92	44
" ".....	No. Twos...	1107	62½	116	56

Experimental work on a much larger scale was carried on in the orchard of Mr. T. L. Kinney of South Hero. Mr. Kinney's orchard is admirably situated for experimental work. The trees are in fine condition, but several varieties of the apples suffer much from the scab, as in all

orchards near the lake. The north half of the orchard was divided into three plots, upon which it was planned to test the relative merits of ammoniacal copper carbonate, modified eau celeste and weak Bordeaux mixture. We also hoped to test the practical gain from spraying on a larger scale than we have heretofore been able to do in our orchard work. The rains of June and July were so incessant, however, as both to prevent spraying when it should have been done and to wash off the mixtures soon after they were applied. As a result there was no appreciable benefit from the spraying that was done.

The work was done with a Field force pump having two discharges, to each of which was fitted twelve feet of $\frac{1}{2}$ -inch hose. To one of these we fitted a ten-foot piece of $\frac{1}{2}$ -inch gas pipe, carrying a Vermorel nozzle at the end. To the other hose we attached twelve feet of $\frac{1}{2}$ -inch rubber tubing, also fitted with a Vermorel nozzle. To elevate this into the trees we used a ten-foot bamboo fish pole. We liked the latter arrangement rather better than the former, but the gas-pipe is cheaper and more durable than the light hose, and would prove the more practical device for most orchardists. With this pump, when it was in good working order, three men and a team applied at the rate of 300 to 400 gallons per day (of ten hours) preparing their own mixtures. It took about two gallons of the mixture to cover an average sized tree.

(b) BROWN SPOT DISEASE OF APPLE LEAVES.

The apple leaves in Mr. Kinney's orchard, and also in various orchards examined near Burlington, were quite seriously attacked by the Brown Spot Disease, caused by the fungus *Phyllosticta pirina*, Sacc. This was first noticed in Mr. Kinney's orchard July 6th, as circular brown spots, varying in size from a shot to a pea, and scattered irregularly over the leaves. From this time on during August the spots increased in number and size. The same trouble was reported to us by Mr. A. J. Grout from Newfane, Vt. The unusual amount of this disease last summer was probably due to the wet weather.

(c) APPLE-RUST AND CEDAR APPLES.

For the past two years we have tested the results of spraying apple trees to check the rust (*Roestelia pirata*, Thaxter), which is another stage of the cedar-apple fungus (*Gymnosporangium macropus*, Lk.), on the common red cedar. As stated in our last report (Rep. 1891, p. 133), spraying, although beneficial, did not entirely check the rust so long as the cedar trees were left in the orchard. In the fall and winter of 1891-92 the red cedars were all destroyed in this orchard, and for a radius of one mile around careful examination was made, and every cedar found was uprooted. The result was magical. In former years many of the apple trees

were entirely defoliated by rust in August. This past summer not a rusted leaf was found in the entire orchard. The moral is plain. Red cedars should not be allowed to grow in or near an apple orchard. From the scientific standpoint the result is interesting as indicating that the mycelium of this fungus is not perennial in the apple, and that the occurrence of the rust on the apples is dependant upon annual reinfection from the red cedar.

IV. SPOT DISEASE OF CUCUMBERS.

(*Cladosporium cucumerinum*, E. and A.)

A peculiar and very destructive disease was found last summer in August and September, attacking both fruit and leaves of cucumbers. On the fruit diseased spots show when the fruit is small, as slightly sunken specks becoming larger with age until they are a quarter or a half-inch in diameter, meanwhile the fruiting threads of the fungus develop, forming a greenish-black velvety coating over the spot. The fungus was most common on the fruit, but was found also on the younger stems and leaves. It was first found in our garden upon "white spine" cucumbers, raised from seed obtained the year before from a New York firm. As the trouble had never been noticed by the market gardeners about here, to whom it was shown, we thought it might have been introduced with this seed, and that this was an isolated attack. In passing through the Burlington market in September, however, we noticed a large quantity of cucumbers which were entirely unsalable from the same disease. They were from the farm of Mr. L. A. Drew. Mr. Drew had never noticed this disease before, and said that the trouble did not attract his attention much in this field this season, most of the spots having appeared after the fruit was marketed. These two outbreaks of the trouble would indicate that it is not a new disease in this section, but that in most seasons its attacks are so slight as to attract little or no attention. Its unusual virulence this past fall was probably due to the warm wet weather of August, the same conditions which aggravated the potato blight. We shall be glad to have any gardeners who notice this disease in the future, write us of the fact.

This disease was first noticed at the Geneva, N. Y. Experiment Station, by Dr. J. C. Arthur in 1887, where "it was so abundant as to ruin the crop for pickling."* No other mention of the occurrence of the disease has come to our notice.

V. GREEN-HOUSE DISEASES.

(a) LETTUCE ROTS.

In our report for 1891 (p. 141) mention was made of a lettuce-rot caused by the fungus *Botrytis vulgaris*. This same trouble again proved serious this winter (1892-3)

* Indiana Exp. Sta. Bul. 19.

Even more destructive, however, was another "rot" which may easily be confused with the *Botrytis* trouble, but which is an entirely different thing. In order to bring out more clearly the distinctions between the two, we have made two drawings which, though made from different varieties of lettuce, will help to bring out the characters of the maladies.

Fig. 2 shows a young plant of the Grand Rapids variety suffering from the attacks of the *Botrytis*. It will be noticed that the decay begins at the base of the lower leaves, where they are in contact with the soil, and proceeds from here upwards and outwards. In the plant in Fig. 2, the younger erect leaves at the heart are still free from disease, the location and degree of the rot being indicated by the shading on the lower leaves. The fungus forms a conspicuous dusty gray mould at the bases and along the midribs of the decaying leaves.

Fig. 3 shows a plant of the "Tennis Ball" variety, diseased in an entirely different way, yet this too is very properly spoken of by our market gardeners as "lettuce rot."

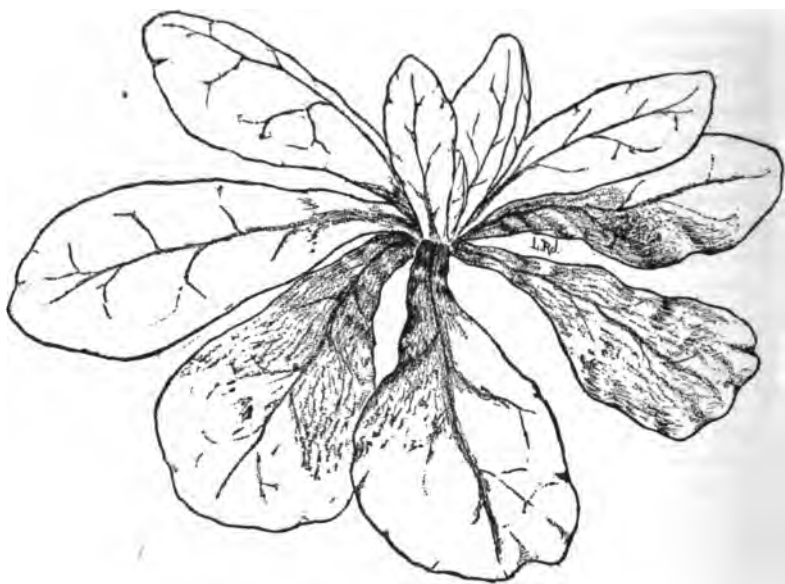
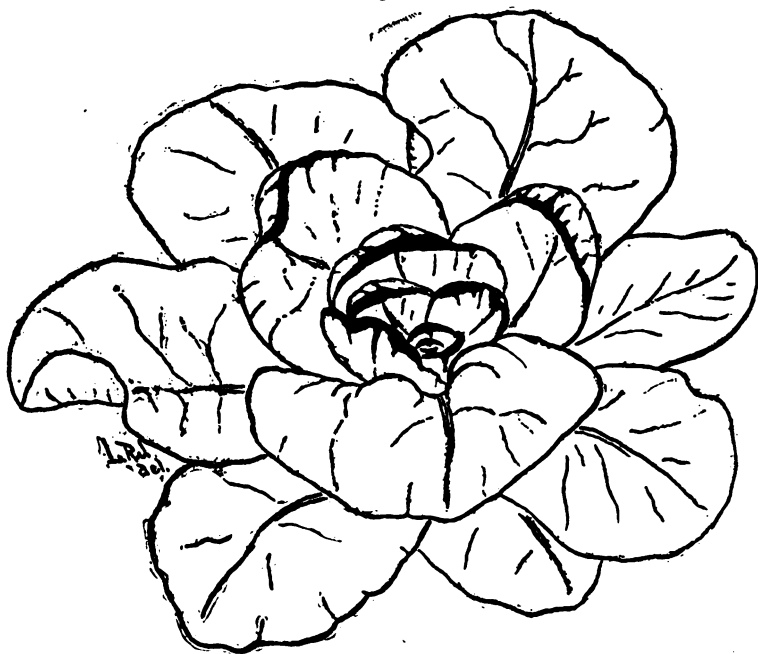
This trouble has been worse in the Experiment Station green-house on the head varieties, but has attacked all more or less seriously. As indicated in the drawing, the disease appears first at the tips and edges of the inner or heart leaves. Its distinction from the other trouble should therefore be easy. In the tender, moist leaves at the heart, the trouble first shows itself as a watery decay at or just inside the margin near the tip. This marginal portion often becoming limp. In leaves more exposed, the tissues blacken soon and become crisp as they die. The decay then passes backward, especially along the veins. This progress is generally rather slow, and as the leaves are growing very fast at this stage they become curled as shown in Fig. 3. Often a growth of the *Botrytis* appears upon these diseased leaves, hastening their decay, but this is a secondary attack and not the primary cause of the trouble. The characters of the disease suggest rather its bacterial nature primarily. The investigations of this matter are in progress, but are not, however, ready for publication.

Occurrence and Remedies.—From what we have seen and learned, we judge that both these troubles are common in lettuce houses. In our experience the *Botrytis* Rot has appeared to be aggravated by an excess of decaying matter, or of moisture in the soil. Precautions in preparing the bed and in watering are suggested, rather than the application of direct remedies. Pick off decaying leaves at the base of plants as soon as seen.

We have had little success in controlling the other rot, except in selecting varieties least liable to the disease.

We sent Mr. W. W. Rawson of Boston, a sample of this, asking what he knew as to its occurrence. We quote from his reply :

"The sample sent is a good type. I have seen lots of this trouble about Boston, not so much in my own houses as in others. The lettuce is all right

*Fig. 2.**Fig 3.*

until a certain stage of its growth, then it begins to rot in the heart. Some varieties are more susceptible than others. With proper handling I can keep it out, though I cannot even tell a man how, so that he can do it. I have to watch the house myself and then instruct the men what to do. The trouble is not caused by the sun, nor is it due to the high temperature; I consider the whole trouble of this rot at the heart to be caused by the dry air in the house at the time that it occurs, and I can run my houses so that there is no such trouble. It is very common, also, to see the rot around the stem [*Botrytis* rot]. This is due to the plant being in that condition when set out, and is caused by the improper conditions of the seed-bed."

A BACTERIAL "STEM ROT" OF LETTUCE.

While investigating these head-rots we found another trouble, the decay of the stem at or just below the surface of the ground. It was in the nature of a "damping-off," except that it occurred in the mature plant rather than the seedling. This decay was very rapid after it began, so that the head would lop over, with the stem completely decayed, before the rot reached the heart or leaves; in a few hours longer these too decayed. This disease is undoubtedly of a bacterial nature. The decaying tissues were found to be teeming with bacteria. One species, a large bacillus, was present apparently to the exclusion of other species in the less advanced stages of the disease. Pure cultures of this were obtained and when inoculated into the stem or heart of healthy plants it invariably led to the entire decay of the plant in from 18 to 48 hours, depending upon the conditions of the house as to temperature and moisture. This trouble probably does not occur often enough to cause serious loss in lettuce houses, though we have had described to us a peculiar "dropping down" disease, as occurring in some of the Boston houses, which seems similar to this trouble. We were perfectly satisfied that the bacillus found would cause this rot under favoring circumstances, providing it gained entrance to the stem. In order to test the danger of infection from soil containing the germs, a young lettuce plant was transplanted into each of four pots under the following conditions:

Pot 1. The decayed portions of a lettuce plant that had gone with the "stem rot" was mixed with the soil.

Pot 2. A decayed head was crushed in a little water and this water poured about the roots of the plant.

Pot 3. The pot was filled with soil taken from about the stem of a plant that had just decayed as the result of inoculation.

Pot 4. The pot was filled with soil taken from about the place where a plant had decayed a few days before.

Pot 5. This pot contained a young cucumber plant and was watered similarly to Pot 2.

Plants 1 to 4 all grew to maturity without any signs of the disease, until considering the experiment over, they were set aside under the shade of some other plants, where it was unusually moist and warm, when the stems of plants in pots 1 and 2 suddenly rotted off, and what was apparently the same bacillus was found swarming in the decaying tissues.

We conclude, therefore, that this "stem rot" is caused by a species of bacterium which may gain entrance from the soil, but is not to be feared in case the house can be kept in proper condition as to heat and moisture. If it does occur, the diseased heads with surrounding soil should be at once removed from the house.

DAMPING OFF.

Some trouble was had in the green-house from "damping-off" of seedling plants, lettuce, balsams and pansies. Many such plants were examined and in all cases the trouble was found to be due to the fungus *Pythium DeBaryanum*, Hesse.

(b) A PECULIAR TOMATO TROUBLE.

The tomato plants in our green-house have suffered seriously this winter (1892-3) from a peculiar trouble. The most characteristic feature of the trouble is a curling downward of the edges of the leaflets, the veins of which are distorted and much swollen in places; yellow or light-colored spots on the leaves, dark-colored lines running lengthwise of the petioles and young branches and stems; the tissues along these lines eventually dying and in the stems often cracking open; fruit small and gnarly. Specimens of our plants were sent to Prof. G. F. Atkinson, of the N. Y. (Cornell) Station, who was investigating a trouble of the same nature in their houses. He pronounced the troubles identical, and I quote from his conclusions, based on a careful study of this "Oedema of the Tomato" (Bul. 53, Cornell Exp. Sta.) "The oedema of the tomato is a swelling of certain parts of the plant brought about by an excess of water which stretches the cell walls, making them very thin and the cells very large. The excess of water may be so great that the cell walls break down, and that part of the plant dying exerts an injurious effect on the adjacent parts. The excess of water in the tissues is favored by the following conditions:

1. Insufficient light.
2. Too much water in the soil.
3. The temperature of the soil may be too near that of the air."

In order to avoid the trouble, therefore, select well lighted parts of the house for tomato plants, give no more water than necessary, aim to have the temperature of the air considerably higher than that of the roots.

DAIRYING.

The leading industry in Vermont is dairying, and naturally the Station has devoted a large part of its work to experiments in this branch of farming. But dairying is taken in the widest sense of the word to include not only the care of cows and the handling of the product, but also the raising of the crops for feeding them, the harvesting and preservation of these crops, and any other problems that have to do with the great dairy industry. It is for this reason that there are grouped in this report under this heading such a variety of topics.

The results of our investigations will be found in the following pages under these heads:

- I. Variations in Quantity and Quality of Milk.
 1. During the Period of Lactation.
 2. During the First Few Weeks after Calving.
 3. Extreme Variations during the Period of Lactation.
 4. Quality of Milk at the End and the Beginning of Lactation.
 5. Variations in Quality of Milk from Year to Year.
 6. Variations in Quality of the Milk from one Calving to the Next.
 7. Effect of Breeding on the Quality of the Milk.
 8. When to Test a Cow.
 9. Testing a Cow at the Fourth Month after Calving.
 10. Testing Once or Twice a Month.
 11. Effect of Grain Feeding.
 12. Summer Dairying vs. All the Year Dairying.
 13. Effect of Abortion on Quantity and Quality of Milk.
- II. Record of the Station Herd for 1892.
- III. Comparative Value of a Cow for Butter and for Cheese.
- IV. Aeration of Milk.
- V. Abnormal Milks.
- VI. The Effect of Weather on the Quality and Quantity of Milk.
- VII. Tests of Dairy Apparatus.
- VIII. Feeding Tests with By-Products of Corn.
- IX. Oat Feed.
- XI. The Change from Barn to Pasture.
- XII. Ensilage of Sugar Beets and Straw.
- XIII. The Proper Time for Harvesting Fodder Corn.
- XIV. Four Methods of Preserving Fodder Corn.

I. VARIATIONS IN QUANTITY AND QUALITY, OF MILK.

By W. W. COOKE.

A full record has been kept at the Station of the milk of each cow year after year, and many thousand analyses made. The voluminous records now on file furnish abundant data for determining the changes that take place in the quantity and quality of the milk of a cow, and the influence that various circumstances have on the quantity and quality.

A study of these records leads to the following conclusions:

1. All cows shrink in quantity of milk as they get farther from calving. If they are farrow, this shrinkage in quantity is accompanied by almost no change in quality, even until they go dry, provided they are still farrow. If they are in calf the milk increases in quality as it decreases in quantity; this increase is slight, but one-twentieth, during the first six months after calving, but becomes quite pronounced just before the cow goes dry.

2. Cows that calve in the spring average giving more milk during the first three months after calving than those that calve in the fall. For the seventh, eighth and ninth months this is reversed. Fall cows show smaller variations in the quality of the milk than cows that calve in the spring.

3. The milk of a cow for the first few days or weeks after calving is very variable in quality. On the average it is thinnest just after calving, becomes slightly richer during the next two weeks and then holds almost uniform in quality for the next four or five months.

4. Cows vary in the quality of their milk from one milking to the next, and from day to day, the quality rising and falling without apparent cause. Such changes are usually within one per cent of fat, but one cow was known to change 2.68 per cent in two days. The least change of any of the cows in the Station herd during an entire period of lactation is 0.33 per cent fat, the average change 1.34 per cent and the greatest change 2.78 per cent. The largest variation in yield of butter is from milk that required 20 pounds of milk to make a pound of butter, to a quality of milk which would require but 11.7 pounds. It is probably possible that cases may occur of a doubling in the richness of the milk during different times in the same period of lactation.

5. Just after calving the milk is poorer in fat, and in solids not fat, than just before the cow went dry. The average drop in fat is 1.13 per cent, the greatest change being 2.35 per cent, and the least 0.49 per cent. The average change in solids not fat is a fall of 0.47 per cent, with variations from a decrease of 1.94 per cent to an increase of 0.42 per cent.

6. Most cows give about the same quality of milk year after year, beginning with this quality at the first calving. There is no general tendency for the milk to become either richer or poorer as the cow grows older.

7. From one calving to the next cows may be expected to vary the general quality of their milk not much more than a sixth of one per cent of fat, and scarcely ever will show a variation of more than a quarter of one per cent.

8. The milk of a heifer tends to agree very closely in quality to that of her dam, the average variation is a third of one per cent of fat and the greatest difference is one per cent in the case of an Ayrshire cow crossed with a Jersey bull.

8. The present cheap, rapid and easy methods of testing cows, leave no excuse for any dairyman's not knowing the quality of the milk of *each one* of his cows. If two tests are made each of a mixed sample of four days' milk, one being taken six weeks after the cow calves and the other six months after calving, the average of these two tests will agree almost exactly with the average quality of the milk given during the entire milking period. There will seldom be a difference of as much as a quarter of one per cent of fat.

10. If it is desired to know from tests nearer together what quality of milk a cow gives, very accurate results will be obtained by making two tests fifteen days apart, four months after the cow calved, each test being on a mixed sample of four days' milk. The average of these two tests with one-eighth of one per cent of fat added, is surprisingly near the truth for the average quality of the year's milk.

11. In the long run, just the same results are obtained whether cows are tested once a month or twice a month.

12. Cows that have been properly fed at the barn do not shrink in quality of milk when turned to pasture. They usually increase both in quality and quantity.

13. Full feeding with grain at the barn and while the cows are on pasture, produces a much larger flow of milk during April and May, and causes the milk flow to keep up considerably later in the fall. No attempt was made to ascertain whether this increase was sufficient to pay for the extra grain.

14. The milk produced by the cows of Vermont during the entire year, contains on the average 4.11 per cent of fat and would, if rightly handled, make a pound of butter from each 22 pounds of milk.

15. The Station herd was troubled with abortion and the trouble ceased after thorough disinfecting with sulphur and a plentiful use of laudanum. There is nothing to prove conclusively that the treatment was the cause of the cessation of the disease.

16. The most noticeable effect of abortion on the quality of the milk, is to make it richer than it would have been had the cow gone full time. This quality, however, falls during the first few months after abortion, until by the third or fourth month it is of about the same quality as would have been given if the cow had calved naturally.

17. The worst effect of abortion is the decreased quantity of milk given, which, with the cows at the Station, amounted to about a third of the full yield.

I. VARIATIONS DURING THE PERIOD OF LACTATION.

It will probably be a surprise to most dairymen to learn how slight are the variations in per cent of fat during the first four or five months of lactation. This holds true for almost all cows individually, and for all herds, whether calving in spring or fall. The table of the results from farrow cows, given on the next page, shows that these scarcely vary in per cent of fat for the first nine months after calving. The total increase of richness for the farrow cows that calved in the fall, is but one-sixteenth in nine months, and the single farrow cow that calved in the spring, showed an almost unvarying quality of milk during the whole of the next year. The average for the eleventh and twelfth months is just the same as for the first and second months after calving.

Comparing these figures with those from the cows that calved in the spring or fall, and were served to calve again in about a year, it will be seen that at the end of the first six months after calving, both farrow cows and those in calf have shrunk the same amount on milk flow, both giving 76 per cent as much as they did the second month after calving. But the cows in calf have increased the richness of their milk one-twentieth, while the farrow cows still give milk of just the same quality. During the next three months, the cows in calf drop to but 50 per cent of their highest yield, and the per cent of fat increases to 114 per cent of what it was during the second month. In the same time the farrow cows make a smaller shrinkage to 64 per cent of their highest yield and a correspondingly smaller increase to 104 per cent of the quality during the second month. These figures would seem to indicate that there are two factors that work to influence the richness of the milk. They indicate that a shrinkage in quantity of milk has a slight tendency to increase its richness. They also indicate that the mere being in calf has a strong tendency to make the milk richer, and would seem to show that this latter is the cause of most of the increased richness that is found in the milk of cows as they dry up preparatory to calving. Some interesting figures on this point are furnished by three cows now in the Station herd. Myrtle went dry seventeen months after calving and when not in calf, and yet the milk of the last month was scarcely different from that of a year before, when she was giving twenty pounds a day. Cloverette at fourteen months after calving, not in calf and giving one-half as much milk as at first, keeps the quality of the milk unchanged. Lolita, at a year after calving, not yet in calf and almost dry, did not give so rich milk as when fresh in milk.

RECORD OF FIVE FARROW COWS THAT CALVED IN THE FALL.

Month after calving.	1	2	3	4	5	6	7	8	9	10	11	12
Average monthly yield of milk, per cow.....	741	813	695	691	623	553	560	530	521	508	512	488
Ratio of months, if second month is 100.....	91	100	85	84	76	67	68	65	64	62	60	60
Average monthly per cent of fat.....	4.68	4.63	4.59	4.71	4.74	4.68	4.98	4.86	4.92	5.21	5.16	5.19
Ratio of months, if second month is 100.....	101	100	99	101	102	101	107	104	106	112	111	112
Average monthly yield of butter fat per cow.....	34.6	37.6	31.9	32.5	29.5	25.8	27.8	25.7	25.6	26.4	26.4	25.3
Ratio of months, if second month is 100.....	92	100	84	86	78	68	73	68	68	70	70	67
Average monthly per cent of solids not fat.....	9.55	9.39	9.40	9.46	9.44	9.61	9.53	9.59	9.48	9.41	9.41	9.41
Ratio of months, if second month is 100.....	101	100	100	100	100	102	101	102	100	100	100	100

RECORD OF ONE FARROW COW THAT CALVED IN THE SPRING.

Month after calving.	1	2	3	4	5	6	7	8	9	10	11	12
Monthly yield of milk.....	761	793	769	769	669	672	548	488	515	496	458	420
Ratio of months, if second month is 100.....	96	100	96	96	84	84	68	61	64	62	57	52
Monthly per cent of fat.....	3.88	3.50	3.44	3.25	3.32	3.38	3.45	3.40	3.20	3.06	3.44	3.40
Ratio of months, if second month is 100.....	95	100	98	92	94	96	98	97	91	87	96	97
Monthly yield of butter fat.....	25.3	27.7	26.4	24.9	22.2	22.7	18.9	16.5	16.4	15.1	15.7	14.2
Ratio of months, if second month is 100.....	91	100	95	89	80	81	68	59	59	54	56	51

RECORD OF SIX COWS THAT CALVED IN THE SPRING,

	Month after calving.									
	1	2	3	4	5	6	7	8	9	10
Average monthly yield of milk per cow.....	819	870	869	871	811	734	593	428	259	123
Ratio of months, if second month is 100.....	94	100	100	100	93	84	61	49	29	14
Average monthly per cent of fat.....	4.00	4.30	4.35	4.25	4.33	4.39	4.57	4.91	5.18	5.47
Ratio of months, if second month is 100.....	93	100	101	98	100	102	106	113	118	127
Average monthly yield of butter fat per cow.....	32.7	37.4	37.8	37.0	35.1	32.2	27.1	21.0	13.4	6.7
Ratio of months, if second month is 100.....	87	100	101	98	93	86	72	56	35	17
Average monthly per cent of solids not fat.....	9.23	9.23	9.25	9.25	9.09	9.06	9.16	9.43	9.49	9.43
Ratio of months, if second month is 100.....	100	100	100	100	98	98	99	102	102	102

RECORD OF FOUR COWS THAT CALVED IN THE FALL.

	Month after calving.								
	1	2	3	4	5	6	7	8	9
Average monthly yield of milk per cow.....	776	734	678	599	529	490	479	496	513
Ratio of months, if second month is 100.....	105	100	92	81	73	67	66	68	70
Average monthly per cent of fat.....	4.49	4.32	4.24	4.33	4.52	4.65	4.73	4.57	4.71
Ratio of months, if second month is 100.....	103	100	98	100	104	107	109	105	109
Average monthly yield of butter fat per cow.....	34.8	31.7	28.7	25.9	23.9	22.7	22.6	22.6	24.2
Ratio of months, if second month is 100.....	109	100	90	81	75	71	71	71	76
Average monthly per cent of solids not fat.....	9.45	9.27	9.70	9.18	9.23	9.36	9.33	9.46	9.44
Ratio of months, if second month is 100.....	101	100	104	99	99	100	100	101	101

Relative Monthly Production of Butter Fat during the Period of Lactation, as compared with the amount yielded the second month.

	1	2	3	4	5	6	7	8	9	10	11	12
Cows that calved in the Spring.....	87	100	101	98	93	86	72	56	35	17		
Cows that calved in the Fall.....	109	100	90	81	75	71	71	71	76			
Farrow Cows that calved in Spring.....	91	100	95	89	80	81	68	59	59	54	56	51
Farrow Cows that calved in Fall.....	92	100	84	86	73	63	73	68	68	70	70	67
Average of all.....	92	100	92	89	85	78	74					

Relative Monthly per cent Fat during the Period of Lactation, as compared with the per cent during the second month.

	1	2	3	4	5	6	7	8	9	10	11	12
Cows that calved in the Spring.....	93	100	101	98	100	102	106	113	118	127		
Cows that calved in the Fall.....	103	100	98	100	104	107	109	105	109			
Farrow Cows that calved in Spring.....	95	100	98	92	94	96	98	97	91	87	98	97
Farrow Cows that calved in Fall.....	101	100	99	101	102	101	107	104	106	112	111	113
Average of all.....	97	100	99	100	101	101	105	107				

These facts should be borne in mind by any one who knows the quality of milk a cow is giving in one period of lactation, and wishes to estimate what the cow has done or will be doing at some other time.

It is interesting to note the changes that occur in the quantity and quality of the milk of those cows that calved in the spring, as compared with those that calved in the fall. It should be remembered that all these cows were fed all they would eat every day in the year, so that it is fair to presume that these differences are really due to the different season at which they calved.

The spring cows increase slightly in milk from the first to the second month after calving, and then hold the milk-flow unchanged for the third and fourth month. This large flow is due to the pasturage, and extends through June, which is the fourth month, for most spring herds. With the fifth month, July, the quantity drops slightly, a little more in the sixth month, and then falls rapidly until the tenth month finds them almost dry.

With the fall cows the drop in quality begins at once after calving and as cold weather comes on they continue to shrink, until the sixth month, which is about February. Thereafter the quantity remains fairly constant, until it actually increases when the cows go to pasture at the ninth month after calving. Comparing yields, we find that the spring cows averaged giving the most milk and making the most butter for the first three months after calving, and that this is reversed for the average of the seventh, eighth and ninth months. For the whole nine months the spring cows have given one-fifth more milk, and one-seventh more butter than the fall cows. The changes that occur in the quality of the milk are less marked with the fall cows than with those that calved in the spring.

Taking the herd as a whole, it will be seen that at the eighth month after calving, the fat in the milk had increased only one-fourteenth over its quality at the second month. For the spring cows the increase is just double as much. If, then, spring cows require in April and May, 24 pounds of milk for a pound of butter, these same cows in October should make a pound of butter from 21 pounds of milk. The fact that many of the creameries get down to but 19 pounds, shows what is becoming well known that the cows that give the richest milk are likely to hold out longest, and their milk form a larger proportion of the late fall milk and increase its average richness.

II. VARIATIONS IN MILK DURING THE FIRST FEW WEEKS AFTER CALVING.

The first few milkings after a cow calves are very irregular in their composition. They show great variations with no apparent cause. It is evident that the milk flow does not become thoroughly established at once at the birth of the calf, and that several days are required for the cow to come to her normal milk. Examples can be found where the colostrum milk is richer than the milk two weeks later, and where it is less rich. Some facts on this point are given in the following table :

Cow.	PER CENT OF FAT IN MILK.		
	Average for First Eight Milkings.	Average Two Weeks After Calving.	Average Four Weeks After Calving.
Lottie.....	3.19	4.15	4.17
No. 5.....	3.02	4.29	4.31
Roxy.....	3.34	4.80	4.82
Minerva.....	4.23	4.94	5.48
Mercedes.....	3.00	3.23	3.33
Dorothy.....	4.35	3.74	3.71
Bright Eyes.....	4.56	5.02	4.79
Pipchin.....	4.15	3.38	3.24
Lottie.....	3.35	3.65	3.99
Average.....	3.67	4.13	4.10

The variations are so great that we can say only that the averages of several cows would indicate that the milk just after calving is not so rich in fat as that of two weeks later. Even by this time the regularity of the milk flow is not established, and some cows increase in fat for the next two weeks, and some decrease, but on the average the quality is maintained without change. This latter belief is strengthened by the records of several other cows. Combining them all, there is given the results as follows :

Cow.	PER CENT OF FAT IN MILK.		
	Two Weeks After Calving.	Four Weeks After Calving.	Difference.
Marburi.....	4.61	4.76	+15
Bright Eyes.....	5.02	4.79	-23
Lottie.....	3.65	3.99	+34
Dorothy.....	3.74	3.71	- 3
Minerva.....	4.94	5.48	+54
Juno.....	3.23	3.56	+33
Lolita.....	4.19	3.92	-27
Cloverette.....	3.33	3.44	+11
Mercedes.....	3.23	3.33	+10
Cigarette.....	4.00	3.65	-35
Dinah.....	3.70	4.14	+44
Pipchin.....	3.38	3.24	-14
Bonnie.....	4.47	4.68	+21
Dollie.....	3.59	3.64	+ 5
Gretchen.....	4.59	4.31	-28
Rena Myrtle.....	4.04	3.53	-51
Average.....	3.98	4.01	0.25

The average per cent of fat in the milk of the sixteen cows for eight milkings two weeks after calving, is 3.98, and of the same cows for eight milkings four weeks after calving, is 4.01. In other words, the average quality of the milk has remained unchanged during these weeks. Of these sixteen cows, nine increase in the per cent of fat during the two weeks, and seven decrease, showing that it is the individuality of the cow that governs, and that what will happen in any particular case cannot be foretold. They varied from a decrease of 0.51 per cent to an increase of 0.54 per cent, with an average variation of 0.25 per cent. No relation can be traced between these changes and the different breeds that formed the herd.

Uniting these conclusions with those already given for the cows during each month of the period of lactation, it will be seen that on the average cows give the thinnest milk just after calving; that it becomes slightly richer during the next two weeks; that then it holds almost uniform in quality for four or five months, after which it gradually increases in richness as the cow comes nearer to calving again, and by the ninth month from calving is only about one-seventh richer than it was during the earlier months.

It is particularly to be noted that the milk of the second and third months is not poorer than that of the first month, as was declared lately by one of the Stations.

III. EXTREME VARIATIONS IN QUALITY OF MILK DURING THE PERIOD OF LACTATION.

There are many cases on record of extraordinary fluctuations in the number of pounds of milk required to make a pound of butter from the same cow at different times of the same period of lactation. In none of these cases has the whole milk itself been analyzed to determine the variations in the amount of butter fat. Nevertheless these records are so numerous and apparently so well authenticated that the general public have come to look on such records as not only possible but easily credible. The more the milk itself is studied, the less likely it seems that any such large variations can occur. It is true that milk varies, indeed is varying constantly from one milking to the next, and that, too, without any apparent cause. But these variations are within comparatively small limits and balance each other so that the average quality for one week is not much different from that of the next week. The records in mind particularly are those in which a given cow is making a pound of butter from 18 to 20 pounds of milk; this is lowered under special feeding or treatment to 12, 10 or even 8 pounds, and afterwards rises again to about the original amount.

The large mass of records of the Station herd furnish abundant material for determining the changes that are likely to occur under ordinary treatment. This statement can be made still stronger—that they show the extent of changes that are likely to occur under any treatment except ex-

posure and starvation, for the herd includes representatives of three breeds and their grades, of old cows and young, of cows giving rich milk and those giving thin. Large changes were made also in feed and each cow at some time during the period of lactation was fed nearly, if not quite, to the limit of her capacity.

Each of the figures given in the table represents the average of the milk for four consecutive days, so as to exclude the slight changes that are always occurring from one milking to the next.

Cow.	Length of Lactation Period. Months.	Average Fat in Milk, Second Month After Calving.	Lowest Fat in the Milk.		Highest* Fat in the Milk.			Difference Between Highest and Lowest Fat.
			Per Cent.	Months After Calving.	Per Cent.	Weeks Before Drying up.	Milk Given Daily, qts.	
La Violette.....	16	5.22	4.88	11	6.27	5	4	1.44
Sadies' Delight.....	14	4.09	3.60	3	5.46	3	5	1.86
Marburi.....	10	-----	4.25	4	5.88	1†	3	1.63
Bread Loaf.....	6	6.03	5.88	3	6.16	2	5	0.33
Bright Eyes.....	10	4.84	4.79	1	7.27	5	5	2.48
Lottie.....	10	-----	3.71	6	5.03	10	7	1.32
Dorothy.....	9	3.73	3.71	1	6.32	3	4	2.61
Minerva.....	9	5.60	4.73	3	5.36	10	6	0.63
Myrtle.....	20	5.50	5.49	5	6.61	12	7	1.12
Juno.....	9	3.40	3.23	1	4.04	3	3	0.81
Lolita.....	9	-----	4.00	6	4.55	2	4	0.55
Cigarette.....	13	3.60	3.34	3	3.90	10	3	0.56
Pipchin.....	9	3.27	3.00	3	5.03	1	3	2.03
Average.....		4.47	4.19		5.53			1.34

The variations are quite large, much larger than those that occur daily from one milking to the next. The least variation is 0.33 per cent, and the greatest 2.48 per cent. The cow Pipchin, during the preceding year, had given milk at one time containing 5.78 per cent fat, making a difference of 2.78 per cent between the highest and the lowest on record for this cow. The change in the quality of the milk of Dolly Athol at the Champlain Valley Fair Grounds in the fall of 1890, was 2.63 per cent fat in two days,

*When giving as much as three quarts of milk daily.

†One week before calving. Never went dry.

and is probably the most violent change on record where the tests were controlled by chemical analysis.

The first nine cows in the table are Jerseys, the next two Ayrshires, and the last two Holstein. The cow Dolly Athol was an Ayrshire, so that each of the three breeds shows cows with small variations and with large. It is probable that the Jerseys are a little more liable to variation than the other breeds, but in proportionate quantity of change, the others are fully equal to the Jerseys.

Having now shown the extreme variations that occurred in the Station herd, the following table shows the corresponding changes that would occur in the pounds of milk required to make a pound of butter. In order to make the variations appear as large as possible, the supposition is made in all cases that 100 pounds of butter fat will make 120 pounds of butter, which is the extreme possibility with a first-class product:

Cow.	POOREST MILK.		RICHEST MILK.	
	Fat. Per cent.	Pounds of Milk to make 1 lb. Butter.	Fat. Per cent.	Pounds of Milk to make 1 lb. Butter.
La Violette	4.83	17.3	6.27	13.2
Sadie's Delight.....	3.60	23.1	5.46	15.2
Marburi	4.25	19.6	5.88	14.1
Bread Loaf	5.83	14.2	6.16	13.5
Bright Eyes.....	4.79	17.4	7.27	11.4
Lottie.....	3.71	22.4	5.03	16.5
Dorothy.....	3.71	22.4	6.32	13.1
Minerva.....	4.73	17.6	5.36	15.5
Myrtle.....	5.49	15.1	6.61	12.6
Juno.....	3.23	25.7	4.04	20.6
Lolita.....	4.00	20.8	4.55	18.3
Cigarette.....	3.34	24.9	3.90	21.3
Pipchin.....	3.00	27.7	5.03	16.5
Average.....	4.19	20.6	5.53	15.5

In the case of Dolly Athol the milk of September 2, 1890, at the home barn, required 18.4 pounds milk to make a pound of butter, while on the fair grounds, September 4th, this was reduced to 12.5. The single milking of the morning of September 5th, was at the rate of 11.6 pounds of milk to the pound of butter.

The figures given are enough to show that during the milking period of a cow, she may give milk varying very greatly in quality. In most cases these changes are pronounced only as the cow becomes nearly dry. Lottie

changes from 22.4 pounds of milk to the pound of butter to 16.5 pounds, while still giving a liberal flow of milk, and Dolly Athol made her most surprising change of quality soon after calving, when in flush of milk.

In no case has a change of one-half been made, as for instance, from 20 pounds to 10 pounds of milk to the pound of butter, but the changes come so close to it, 20 to 11.7, that even this extraordinary change must be considered within the range of possibility.

IV. QUALITY OF MILK AT THE END AND AT THE BEGINNING OF LACTATION.

It is known that the milk becomes richer as the cow dries up, and that on calving again the milk falls back to its normal quality. The records of the Station herd contain some figures from which a judgment can be formed of the usual amount of the change that takes place at this time. In compiling them it has seemed best to use not the figures for either the last or the first milkings, because they are so very irregular, but to take figures that represent the general character of the milk for the last few weeks before drying up, and for an equal period after calving.

Average Fat and Solids not Fat, for one month, beginning six weeks before drying up, and for one month, beginning two weeks after calving.

Cow.	BEFORE GOING DRY.		AFTER CALVING.	
	Fat.	Solids not Fat.	Fat.	Solids not Fat.
Pipchin.....	4.73	10.06	3.78	9.00
Pipchin.....	5.62	10.82	3.27	8.88
Dorothy.....			3.73	9.05
Dorothy.....	6.28	10.02	4.77	9.38
Dorothy.....	5.32	9.10		
Lolita.....	4.54	8.75	4.05	9.17
Juno.....	4.20	9.05	3.40	8.85
Dinah.....	4.38	9.28	3.95	9.23
Minerva.....	5.20	9.74	4.98	9.79
Mercedes.....	4.97	9.53	3.88	9.21
Bright Eyes.....	6.99	9.71	5.24	9.66
Sadie's Delight.....	5.45	10.02	4.37	9.20
Marburi.....	5.79	10.38	4.69	9.64
Lottie.....	4.77	9.65	3.82	8.91
Average.....	5.25	9.77	4.12	9.23

All decrease in fat after calving. The general rule seems to be a decrease in solids not fat, but two of the cows show no change, and one of them shows an actual increase of solids not fat, after calving. In this latter

case, that of Lolita, not only are the solids not fat larger after calving than before, but after keeping up for six months they begin to drop again as she dries up until the last few weeks of her milk flow the solids not fat have fallen below 8 per cent.* The per cent of fat in the milk falls on the average 1.13 per cent, the greatest change being 2.35 per cent, and the least 0.49 per cent. The average drop in solids not fat is 0.47 per cent, varying from a decrease of 1.94 per cent to an increase of 0.42 per cent.

The cow Pipchin seems to have the most variable record. The figures are given for two consecutive calvings, in both of which considerable change occurred in the character of the milk, but the changes at one calving are about twice as large as at the other.

V. VARIATIONS IN QUALITY OF MILK FROM YEAR TO YEAR.

The question is often asked whether or not a cow has a fixed quality of milk which she gives each year through her life. The same question is more often asked in another form, whether the milk given by a heifer during her first milking period is a correct indication of what it will be as to quality in the future? But little has been published on this point, and the following records, though quite incomplete, are given to furnish additional data on the subject:

Three of the cows now at the Station were purchased in 1888, and quite full records are at hand for the year 1889. Then but few analyses were made in 1890 and 1891, while from January 1, 1892, to the present time, there are continuous records of quality. The cow Minerva has calved regularly each spring, and gave in the spring of 1889, milk averaging 5.44 per cent fat; in 1892, 4.80; in 1893, 5.05. The average quality of her milk for the whole year, 1892, is 5.12 per cent fat. The cow Dorothy is daughter of Minerva. During the spring of 1889, with her first calf, the milk averaged 4.78 per cent fat. In 1892, it was just the same quality, and in 1893, 5.05 per cent fat. So that now, when six years old, her milk is of the same quality as that of her dam. Previous to this year it usually has been a little less rich, the average for 1892 being 4.73, as against 5.12 per cent fat in the milk of Minerva.

The cow Lottie was four years old in 1888, and dropped her calf in the fall. Her tests for that and succeeding years are 4.65, 4.09, 4.37, 4.52 and 3.70. For the following years in the spring the tests are 5.27, 4.71, 4.37, 3.87 and 4.40. There is a noticeable change of quality during the year 1892. The average for the whole year is only 4.00 per cent, whereas in the other years it would run rather over than under 4.50 per cent fat.

The queer feature of the case is that this lowering of quality begins in the middle of one period of lactation, extends through the rest of that

*In the last Report of this Station, the statement was made that the solids not fat in the milk of *herds* never go below 8.10, and this milk of a single cow at 7.81 solids not fat must be considered as abnormal milk,

period and the first few months of the next, when the quality returns to its normal condition. The period of poorer milk lasted for just about a year. No reason is known for it. It was apparently an "off year."

Thus the three cows, whose records we have for the longest periods, are giving now milk of essentially the same composition as that of five years ago. The variations are less than half a per cent of fat. During these years there have been wider variations, but these have been both toward the richer and the poorer, and there is nothing to indicate that as the cows grew older there was a tendency toward increasing or decreasing the quality of the milk.

The records of other cows for shorter periods seem to bear out these statements:

The cow Juno, at nine years old in 1889, averaged 3.65 per cent fat during April and May; in 1891 the test was 3.49, and in 1892 the same. The average of the whole milking period in 1892, was 3.64.

The cow Filia dropped her first calf the fall of 1888, and her milk tested that winter 6.45 per cent fat. The next year it was 6.61, and the next 6.22.

The cow Pipchin has a test of 3.29 per cent fat for the spring of 1892, and 3.26 for the spring of 1893, the average for the year 1892 being 3.40.

The cow Cigarette, for the years 1891, '92 and '93, tests 4.00, 3.51 and 3.87, with an average for the year 1892 of 3.65. The cow Dinah has a test in the spring of 1890 of 3.69 per cent fat, in 1892 of 3.95, and 3.69 again in 1893, while the average for 1892 is 3.83. Lastly, the cow Roxy, standing in the barn almost continuously for four years, gives a surprisingly uniform quality of milk, the yearly tests at the same time from calving being 4.48, 4.47, 4.25 and 4.46 per cent fat, with an average for a year of 4.31 per cent.

Hence these fragmentary records, so far as they go, would indicate that each cow has a certain normal quality of milk derived from her ancestors or determined by her conditions; that this quality is produced at once during her first milking period, and though the quantity may be increased or diminished as she grows older, the same general character of the milk will be maintained through life, with no general tendency to becoming either richer or poorer. But cows also may and do vary the quality of the milk within small limits from one milking period to another and without apparent cause.

VI. VARIATIONS IN QUALITY OF THE MILK FROM ONE CALVING TO THE NEXT.

Closely related to the preceding question, indeed included in it, is the question of how much variation is to be expected in the quality of the milk of a cow from one year to the next. Quite a number of cases are in the Station records bearing on this point, in addition to those given under the last heading.

RECORD OF SIX COWS THAT CALVED IN THE SPRING.

Month after calving.	1	2	3	4	5	6	7	8	9	10
Average monthly yield of milk per cow.....	lbs. 819	870	869	871	811	734	593	428	259	123
Ratio of months, if second month is 100.....	94	100	100	100	98	84	61	49	29	14
Average monthly per cent of fat.....	4.00	4.30	4.35	4.25	4.33	4.39	4.57	4.91	5.18	5.47
Ratio of months, if second month is 100.....	93	100	101	98	100	102	106	113	118	127
Average monthly yield of butter fat per cow.....	lbs. 32.7	37.4	37.8	37.0	35.1	32.2	27.1	21.0	13.4	6.7
Ratio of months, if second month is 100.....	87	100	101	98	93	86	72	56	35	17
Average monthly per cent of solids not fat.....	9.23	9.23	9.25	9.25	9.09	9.06	9.16	9.43	9.49	9.43
Ratio of months, if second month is 100.....	100	100	100	100	98	98	99	102	102	102

RECORD OF FOUR COWS THAT CALVED IN THE FALL.

Month after calving.	1	2	3	4	5	6	7	8	9
Average monthly yield of milk per cow.....	lbs. 776	734	678	599	529	490	479	496	513
Ratio of months, if second month is 100.....	105	100	92	81	73	67	66	68	70
Average monthly per cent of fat.....	4.49	4.32	4.24	4.33	4.52	4.65	4.72	4.57	4.71
Ratio of months, if second month is 100.....	103	100	98	100	104	107	109	105	109
Average monthly yield of butter fat per cow.....	lbs. 34.8	31.7	28.7	25.9	23.9	22.7	22.6	22.6	24.2
Ratio of months, if second month is 100.....	109	100	90	81	75	71	71	71	76
Average monthly per cent of solids not fat.....	9.45	9.27	9.70	9.18	9.22	9.36	9.38	9.46	9.44
Ratio of months, if second month is 100.....	101	100	104	99	99	100	100	101	101

Relative Monthly Production of Butter Fat during the Period of Lactation, as compared with the amount yielded the second month.

	1	2	3	4	5	6	7	8	9	10	11	12
Cows that calved in the Spring.....	87	100	101	98	93	86	72	56	35	17		
Cows that calved in the Fall.....	109	100	90	81	75	71	71	71	76			
Farrow Cows that calved in Spring.....	91	100	95	89	80	81	68	59	59	54	56	51
Farrow Cows that calved in Fall.....	92	100	84	86	73	68	73	68	68	70	70	67
Average of all.....	92	100	92	89	85	78	74					

Relative Monthly per cent Fat during the Period of Lactation, as compared with the per cent during the second month.

	1	2	3	4	5	6	7	8	9	10	11	12
Cows that calved in the Spring.....	93	100	101	98	100	102	106	113	118	127		
Cows that calved in the Fall.....	103	100	98	100	104	107	109	105	109			
Farrow Cows that calved in Spring.....	95	100	98	92	94	96	98	97	91	87	98	97
Farrow Cows that calved in Fall.....	101	100	99	101	102	101	107	104	106	112	111	113
Average of all.....	97	100	99	100	101	101	105	107				

by the same bull, Cassimir, out of the cows Cigarette and Pipchin. Cloverette's milk tests 3.37 per cent. fat as compared with Cigarette's 3.65, while Bess gives milk with 3.27 per cent. fat to be compared with the 3.40 per cent. of Pipchin. These show close relationship and proportion.

The cow Beauty is out of the Cow No. 17, the milk of the daughter averaging 5.37 per cent. fat, and that of the mother testing 4.86. The characteristics of the sire's dam are not known.

The above facts can be grouped in the following table:

Cows.	Per cent. of Fat in the Milk of		
	Mother.	Daughter.	Difference.
Roxy and Pansy.....	4.41	4.37	—0.04
Minerva and Dorothy.....	5.12	4.73	—0.39
No. 5 and Bonnie.....	4.44	4.58	+0.14
Minerva and Marguerite.....	5.12	5.01	—0.11
Dorothy and Floss.....	4.73	4.62	—0.11
Juno and Gretchen.....	3.53	4.56	+1.03
Cigarette and Cloverette.....	3.65	3.37	—0.28
Pipchin and Bess.....	3.40	3.27	—0.13
No. 17 and Beauty.....	4.86	5.37	+0.51
Average.....	4.36	4.43	0.31

With the exception of one case, where there is cross breeding of Jersey and Ayrshire, the quality of the milk of mother and daughter agrees quite closely. On the average they are the same with an average variation of about one-third of one per cent. of fat and extreme variations of from a third of a per cent. poorer to a whole per cent. richer.

These facts, while very fragmentary, seem to indicate that there is not much hope of greatly influencing the per cent of fat in the milk by simply breeding, except as a bull from a herd giving rich milk may be used to help increase the richness of the milk of cows that give very thin milk, as shown above in the case of Gretchen. In a herd already giving a good quality of milk the farmer is confined to selection as his method of increasing the richness of the milk, breeding being used to preserve what has been gained by care, feed and selection.

VIII. WHEN TO TEST A COW.

All dairymen recognize the desirability of knowing the general quality of the milk given by their cows. They also know from experience that to

test even a single cow every week or month of the year is a very laborious undertaking. When the only way to know the quality of the milk was to set it by itself, skim and churn the cream, farmers were not to be blamed if they did this but unfrequently. It was customary then to make a single test a few weeks after calving, when the cow was on flush of feed and at her best and judge of her worth by this single test. Now that cheap, rapid and easy tests for fat in milk have been invented, no dairyman has any excuse for not knowing the goodness or badness of each of his cows. But even with these later simple tests it is desirable that as little labor should be bestowed on the matter as is consistent with ascertaining the desired information, i. e., the average quality of the milk of the cow. It is evident that if the milk is tested at frequent intervals all through the year a very correct knowledge of its character will be obtained. It is exceedingly desirable to know whether close enough results can be obtained by less frequent testing.

The cows of the Station herd are tested for sixteen milkings of each month, and every milking is weighed so that the average quality of the milk as well as its total quantity for each milking period is accurately known.

These records were studied to see how few tests would yield fairly correct results. It is known that the milk is thinnest just after calving and that it becomes richer as the cow dries up or becomes again in calf. It would naturally be supposed that the average of tests made in the early part of the milk flow and in the latter part would not be far from the truth. To ascertain the facts on this point, tests were made six weeks after the cow calved, and again six months after calving, and the mean of these results compared with what we knew to be the actual average composition of the entire milk yielded during the milking period. By this average composition is meant the test that would have been obtained could all the milk have been mixed together in one vat. It will be noticed that this average composition is not much richer than the poorest milk yielded, for although the milk becomes considerably richer during the last few weeks of lactation, yet the quantity yielded at this time is so small that it has but little influence to raise the average quality of the entire milk yield.

The following table shows the results obtained by this comparison, each test being of a composite sample of the milk for four consecutive days:

AVERAGE PER CENT OF FAT IN THE MILK.

	Six Weeks After Calving.	Six Months After Calving.	Average.	Average for the Year.	Difference.
La Violette.....	5.05	5.76	5.41	5.41	0.00
Sadie's Delight...	4.80	5.19	4.75	4.88	+0.07
Marburi	4.68	5.49	5.09	4.98	+0.11
Marburi	4.46	5.09	4.77	4.92	-0.15
Bread Loaf.....	6.03	6.16	6.10	5.70	+0.40
Bright Eyes.....	4.88	6.18	5.53	5.66	-0.13
Lottie.....	3.88	3.96	3.92	4.05	-0.13
Dorothy.....	4.89	5.13	4.76	4.78	+0.03
Minerva.....	5.87	5.03	5.45	5.12	+0.33
Lottie.....	4.24	4.12	4.18	4.09	+0.09
Myrtle.....	5.65	6.62	6.13	5.94	+0.19
Juno.....	3.56	3.62	3.59	3.64	-0.05
Lolita.....	3.91	3.67	3.79	3.90	-0.11
Cloverette	3.56	3.40	3.48	3.37	+0.11
Mercedes	3.97	3.64	3.81	3.69	+0.12
Cigarette.....	3.54	3.32	3.48	3.65	-0.22
Pipchin.....	3.24	3.43	3.34	3.40	-0.06
Dinah.....	3.76	3.65	3.61	3.83	-0.22
Beauty.....	5.53	5.79	5.66	5.59	+0.07
Average.....	4.44	4.28	4.56	4.54	0.14

The results show that on the average the mean of a test at six weeks after calving, and again six months after calving, agrees almost exactly with the average character of the milk for the entire milking period. But in the case of the individual cows, there are some variations. The extremes of variation are from -0.22 to $+0.40$, with an average variation of 0.14 . This means that when results by this method have been obtained, it is probable that they are within one-seventh of one per cent of correct; though it is possible that they may be from four-tenths of a per cent too high to one-fifth of a per cent too low. In the average of several cows they can be relied upon as very closely correct.

IX. TESTING A COW AT THE FOURTH MONTH AFTER CALVING.

If the milk of a cow is poorest just after calving, and richest near the close of the milking period, there must be some time between these dates when the milk is of average quality. Comparisons were made of the milk of each month with the average, and it was found that the fourth month gave the best results. In other words, if we know the average quality of the milk yielded by the cow four months after calving, we can estimate very closely the quality of the milk she will give during the whole year.

It is not safe to take the figures of a single test as representing the

average quality of the milk of that or any month. We have found, however, that by making two tests, fifteen days apart, each test being a composite sample of eight consecutive milkings, we get very reliable results.

The table subjoined gives the results obtained by these comparisons, the first of the two tests being taken as nearly as possible four months after the cow calved, and the second test fifteen days later, and the results of these two tests averaged:

Cow.	AVERAGE PER CENT OF FAT IN MILK.		
	Four Months After Calving. Two Tests.	During the Whole Milking Period.	Difference.
LaViolette.....	5.39	5.41	—0.02
Sadie's Delight.....	4.43	4.68	—0.25
Marburi.....	4.89	4.92	—0.03
Bread Loaf.....	5.51	5.70	—0.19
Bright Eyes.....	5.43	5.66	—0.23
Lottie.....	3.88	4.05	—0.17
Lottie.....	3.76	4.09	—0.33
Dorothy.....	4.80	4.73	+0.07
Minerva.....	5.19	5.12	+0.07
Juno.....	3.68	3.64	+0.04
Lolita.....	3.61	3.90	—0.29
Cloverette.....	3.32	3.37	—0.05
Cigarette.....	3.69	3.65	+0.04
Pipchin.....	3.22	3.40	—0.18
Dinah.....	3.79	3.83	—0.04
Beauty.....	5.26	5.59	—0.33
Average.....	4.36	4.48	0.15

A study of the above figures will show that the milk of the fourth month after calving is an excellent guide to the general quality of the milk of the cow. The extremes of variation are less than half a per cent, the average variation only 0.15 per cent, and the average of all tests as compared with the average for the milking period is 0.12 per cent lower. If, then, you know the quality of milk the cow is giving during the fourth month after calving, you can feel reasonably sure that by adding one-eighth of a per cent to it you will have a very close approximation to the average quality of the milk for the whole milking period.

X. TESTING ONCE OR TWICE A MONTH.

The cows at the Station Farm are tested twice each month. A comparison has been instituted between the results thus obtained and what would have been obtained had the test at the middle of the month been dropped. The figures below show the results :

Cow.	AVERAGE PER CENT OF FAT IN MILK.		
	One Test a Month.	Two Tests a Month.	Difference.
La Violette.....	5.43	5.46	+0.03
Sadie's Delight.....	4.65	4.69	+0.03
Marburi.....	4.88	4.92	+0.04
Bread Loaf.....	5.90	5.84	-0.06
Bright Eyes.....	5.85	5.82	-0.03
Lottie.....	4.10	4.10	0.00
Dorothy.....	4.88	4.94	+0.06
Minerva.....	5.01	5.07	+0.06
Myrtle.....	5.83	5.87	+0.04
Juno.....	3.74	3.75	+0.01
Lolita.....	3.91	3.88	-0.03
Cloverette.....	3.39	3.36	-0.03
Mercedes.....	3.78	3.74	-0.04
Cigarette.....	3.70	3.67	-0.03
Pipchin.....	3.77	3.71	-0.06
Beauty.....	3.35	3.36	+0.01
Average.....	4.51	4.51	0.03

It is evident that we would in the long run get practically the same results whether we tested once or twice a month.

XI. EFFECT OF GRAIN FEEDING.

The records on hand enable us to form some estimate of the effect of liberal feeding on the quantity and quality of the product, during the period of lactation.

Most of the cows of Vermont calve in the spring, from February to May. We have the records of twenty such herds in Franklin County, of about twenty cows each. Averaging these records we get figures based on the doings of over four hundred cows, hence the results ought to be quite reliable. All results are calculated to thirty days in a month.

In comparison with these is given the record of six cows at the Experiment Station farm that calved in the spring and were fed at the barn heavily with grain, hay and ensilage, before and during pasturage, and also after their return to the barn until they went dry. The Franklin County cows were fed but little grain at the barn. They were turned to pasture in May, and fed no grain while on pasture. As the pastures dried up in August and September, but little care was taken to keep up the flow of milk. Almost no grain was fed, and not much of fodder corn or fall mowings. When they came to the barn in November, no pains were taken in most cases to keep them along in milk. The feeding then may be said to be rather poor at the two ends of the season, and an abundance of the best of feed in the middle.

Under these conditions there is a marked increase in the quantity of milk under better feed, reaching its height when the feed is best in June, and shrinking still more remarkably when cold weather and short feed occur in November.

RECORD OF TWENTY HERDS IN FRANKLIN COUNTY.

	April.	May.	June.	July.	August.	Sept.	October.	Novemb'r.
Average daily yield of milk per herd.....lbs.	242	313	403	365	300	261	210	114
Ratio of different months if June is 100.....	60	75	100	87	72	64	50	26
Average per cent of fat in milk.....	3.60	3.75	3.86	3.90	4.04	4.36	4.61	5.07
Ratio of different months, if June is 100.....	93	97	100	101	104	112	119	131
Average daily yield of butter fat per herd.....lbs.	8.7	11.3	15.6	13.7	11.7	11.4	9.4	5.8
Ratio of different months, if June is 100.....	56	73	100	88	75	73	60	37

RECORD OF SIX COWS FROM THE STATION HERD.

	April.	May.	June.	July.	August.	Sept.	October.	Novemb'r.
Average monthly yield of milk per cow.....lbs.	792	867	948	814	723	711	531	340
Ratio of different months, if June is 100.....	84	91	100	86	76	75	56	36
Average per cent of fat in milk.....	4.07	4.38	4.38	4.28	4.37	4.52	4.70	4.83
Ratio of different months, if June is 100.....	93	100	100	98	100	103	107	110
Average monthly yield of butter fat per cow.....lbs.	32.2	33.0	41.5	35.8	31.6	32.1	25.0	16.4
Ratio of different months, if June is 100.....	73	91	100	84	76	77	60	40

The changes in quality are especially worthy of note. There is a prevailing idea that when cows go out to grass the milk gets poorer in quality as it increases in volume. Some States recognize this belief in their statutes by lowering the legal milk standard during May and June. Many tests at this Station during four consecutive seasons, have shown the incorrectness of this belief, and the figures of these four hundred cows show the same very conclusively.

The per cent of fat is lowest just after they calve; there is a rapid increase when they go to pasture, and a continued increase each month until at the last the increase is again rapid.

It is to be noted, however, that this increase of fat per cent is not enough to counterbalance the decrease in the weight of the milk, so that the total daily fat decreases during the fall months in spite of the increased richness of the milk.

If the records from Franklin County are compared with those of the Station herd that have been full fed all the year, it will be seen that the latter cows show no such violent changes as the former. When the cows go to pasture the milk increases quite a little, but fat remains about the same, and for the first eight months of lactation there is only a slight change in per cent fat, and no very large decrease, and no sudden decrease in quantity of milk. Also it will be noted that in our herd there is not so large an increase in per cent fat at the end of the period of lactation. But few cows change one per cent from richest milk of last month before drying up, to thinnest milk after calving.

The influence of the full feeding is seen most strongly during the months of April and May, which yield with grain, one-third more milk and butter fat than without. An influence after June is seen, but not so pronounced. Those having grain shrink in milk flow only nine-tenths as fast as those not having grain, and have the advantage of only one-twenty-fifth in the shrinkage of butter fat.

Of course this is not a strict comparison of the effects of feeding grain on the total yield, or of the financial side of the question, but merely of the effect the grain has in increasing the flow of milk at once when the cow calves and of maintaining the milk flow for a longer period in the latter part of lactation.

XII. SUMMER DAIRYING *vs.* ALL-THE-YEAR DAIRYING.

Through the courtesy of the Franklin County Creamery Association of St. Albans, Vt., we have been furnished the figures of their work for the year 1892, and are able to obtain the results from them that are given on the next page. The figures show that not more than one-twentieth of the cows are in winter dairies, and this can therefore be taken as the probable average for the whole of Franklin county, and probably for the whole State of Vermont. Comparing these with the figures of the summer dairies it will be seen that the differences are slight, except for April and November, and these large differences during these two months are due in part to the smaller number of separator skimming stations in operation during those months:

RECORD OF FRANKLIN COUNTY DAIRIES FOR ONE YEAR.

Month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Average per cent of fat in milk	4.46	4.16	3.93	3.69	3.88	3.96	3.93	4.08	4.34	4.62	4.94	4.84
Ratio of months, if June is 100	113	105	99	93	98	100	99	103	110	117	125	122
Ratio of yield of milk by months, if June is 100	4	4	10	23	67	100	95	80	68	54	15	7
Ratio of yield of butter fat by months, if June is 100	5	4	10	21	65	100	94	82	75	63	19	9

RECORD OF STATION HERD FOR ONE YEAR.

Month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Average per cent of fat in milk	4.26	4.53	4.22	4.30	4.28	4.40	4.21	4.29	4.31	4.40	4.25	4.30
Ratio of months, if June is 100	96	102	95	97	97	100	95	97	97	100	96	97
Ratio of yield of milk by months, if June is 100	60	57	76	76	92	100	97	79	83	81	66	63
Ratio of yield of butter fat by months, if June is 100	58	59	73	74	90	100	93	77	81	81	64	61

These are the records for more than 10,000 cows of northwestern Vermont, taken good, bad and indifferent, *i. e.*, the whole herd taken, if any, for an entire year, and show that the average per cent of fat in the entire amount of milk for the whole year is 4.11 per cent fat. Since the cows that give the richest milk give the least quantity, this does not represent the average per cent of fat in the milk of the cows individually. From tests at the Station it is probable that this latter per cent is 0.18 per cent higher than the one given above, or 4.29 per cent for the cows individually. As these cows are a fair average of the State, this per cent may be considered very closely correct for Vermont.

These Franklin county herds are typical summer dairies in contradistinction to which may be given the record of our Station herd for the same time. The endeavor is made to have the milk supply at the Station as nearly uniform as possible throughout the year, but if there is any difference, to have the larger amount in winter, and yet the difficulty of getting cows to calve in the fall and the superiority of summer feed has always given us our largest amount in June, and smallest in December and January. The cows in this herd calved at irregular dates all through the year, but principally in February, March, September and October.

The most noticeable difference between our herd and those of the summer dairies, is in the uniformity of the per cent of fat in the milk. The quality of the milk is practically constant for the whole year, while in the summer dairies the milk for November contains almost half as much again fat for each one hundred pounds as the milk in April. This increase of the per cent of fat in the Franklin County herds in the late fall is noticeably greater than is found in the Station herd. It is probably due to the fact that most of the herds contain some Jerseys, and these would naturally hold out longer in their milk than the others, so that a larger proportion of the milk of November would be from Jerseys and Jersey grades.

XIII. EFFECTS OF ABORTION ON QUANTITY AND QUALITY OF MILK.

During the winter of 1892-3, the Station herd was troubled by abortion. No reason for the outbreak has been discovered. The first cow that aborted had been already removed to another barn two weeks previous; the second aborted in the stable with the rest of the herd and was at once removed. The next day another one aborted in the same stable, and was not removed, and two weeks later the fourth one aborted. There were then nine more cows in calf in the stable. The whole herd was turned into the yard and the stable thoroughly disinfected by burning sulphur, the fumes being kept in the barns for about two hours. The same was repeated the next day, and again two days later. For the next few weeks about half the cows in calf were kept continually under the influence of laudanum, and a careful watch kept of all. Three cows showed signs of aborting and in each case

they were at once given large doses of laudanum, and kept fully under its influence until the signs of uneasiness ceased. All of the nine cows passed through their full time and dropped good, healthy, vigorous calves.

Records were kept of all the cows and enable us to ascertain the effect of the abortion on the yield of the cows. One of the four cows, Dorothy, had just gone dry, and the others were still in milk. All aborted when between six and seven months in calf.

Dorothy, due January 30, aborted November 20, when six and two-thirds months along, and just after drying up, the last milking having been November 5th. The year before when she calved at full time, she gave 30 pounds milk daily, testing 3.73 per cent fat. Her milk tested 6.28 per cent fat just before she went dry, and after calving she gave only 19 pounds milk daily, testing 4.77 per cent fat. Five months after calving at full time she was giving 22 pounds milk daily, testing 4.86 per cent fat. Five months after aborting she was giving but 13 pounds daily, testing 5.19. The loss in her case from abortion in five months, is 1,700 pounds milk and 70 pounds butter, or nearly one-half of the entire product.

Cigarette, due March 8, aborted December 16, when a little over six months in calf. She was then giving 19 pounds of milk daily, testing 3.82 per cent fat, and after aborting she kept the quantity just the same, but the quality increased to 4.39 per cent fat. A year before when calving at full time, she gave 36 pounds of milk daily, testing 3.60 per cent fat, and five months after calving the quantity had only fallen to 32 pounds daily with 3.69 per cent fat. At five months after aborting she was giving 22 pounds daily, testing 3.87 per cent fat. This would amount in five months to a loss of 2,000 pounds of milk and 60 pounds butter, about one-third of the entire product.

Dinah is a very vigorous cow with a wonderfully hardy constitution. She had already made four hundred pounds of butter since she calved, when on December 15 she aborted at six months. She was then giving 19 pounds of milk daily, testing 3.69 per cent. of fat, and after aborting she gave 31 pounds daily, testing 3.53 per cent. fat. The year before after calving at full time she gave 43 pounds milk daily, testing 3.95 per cent. fat. Five months later she was giving 36 pounds of milk daily, testing 3.54 per cent. fat. Five months after aborting she gave 27 pounds daily, testing 3.69 per cent. fat. Thus she has made no special change in the quality of the milk before and after abortion, but the quantity has been less both immediately after aborting and for the next five months, the total loss in these months amounting to 1650 lbs. milk and 75 lbs. butter, or one-third of total amount of product.

La Violette was due March 10, and aborted January 3, when nearly seven months in calf. She had been then in milk for sixteen months, was nearly dry and was giving but 4 pounds of milk daily, testing 5.97 per cent.

fat. After aborting she gave 23 pounds daily, testing 5.83 per cent. fat. When she calved before, at full time, she gave 16 pounds of milk daily, testing 5.17 per cent. fat. So that apparently she was none the worse for her mishap. At five months after calving regularly she was giving 15 pounds daily, testing 5.39, while at five months after aborting she was giving 21 pounds milk daily, testing 5.25 per cent. fat.

These facts can be expressed in the table that follows, which gives the average daily yield of milk for the thirty days beginning two weeks before the cow aborted, with the average per cent. of fat and of solids not fat. In comparison with this, there is given the milk yield, per cent. of fat and of solids not fat for the thirty days beginning two weeks after the cow aborted, and the same data for the last calving previous, when the cow went full time.

Cow.	Before Aborting.			After Aborting.			At Full Time.		
	Daily Milk Yield	Fat.	Solids not Fat.	Daily Milk Yield	Fat.	Solids not Fat.	Daily Milk Yield	Fat.	Solids not Fat.
	lbs.	per ct.	per ct.	lbs.	per ct.	per ct.	lbs.	per ct.	per ct.
Dorothy	Dry	6.28	10.02	19	4.77	9.38	30	3.73	9.08
Cigarette	19	3.82	9.01	19	4.89	9.07	36	3.60	8.41
Dinah	19	3.69	8.84	31	3.53	8.92	43	3.95	9.23
La Violette....	4	5.97	9.94	23	5.83	10.42	16	5.17	9.96
Average omitting Dorothy	14	4.49	9.26	24	4.58	9.47	32	4.18	9.20

The after effects of the abortion can be seen from the following table :

Cow.	Five Months after Aborting.			Five Months after Calving at Full Time.		
	Daily Milk Yield.	Fat.	Solids not Fat.	Daily Milk Yield.	Fat.	Solids not Fat.
	lbs.	percent.	per cent.	lbs.	percent.	per cent.
Dorothy.....	12	5.19	9.17	22	4.86	9.14
Cigarette.....	22	3.87	8.96	32	3.69	8.62
Dinah.....	27	3.69	8.93	36	3.54	8.97
La Violette.....	21	5.25	9.76	15	5.39	9.77
Average.....	20	4.50	9.21	26	4.37	9.18

Another table can be constructed, showing the variations in the quality of the milk for each month separately of the first five months after aborting and after calving at full time.

PER CENT OF FAT IN MILK.

Month.	Dorothy.		Cigarette.		Dinah.		La Violette.	
	After Aborting.	At Full Time.	After Aborting.	At Full Time.	After Aborting.	At Full Time.	After Aborting.	At Full Time.
1	4.77	3.73	4.39	3.60	3.53	3.95	5.83	5.17
2	4.74	4.54	4.39	3.60	3.68	3.92	5.67	5.22
3	4.99	5.02	3.77	3.66	3.48	3.90	5.11	5.23
4	5.08	4.96	3.90	3.32	3.69	3.79	5.35	5.28
5	5.19	4.86	3.87	3.69	3.69	3.54	5.25	5.39
Average.....	4.95	4.62	4.06	3.57	3.61	3.82	5.44	5.26

AVERAGE OF THE FOUR COWS

Month.	PER CENT OF FAT IN THE MILK.	
	After Aborting.	At Full Time.
1	4.68	4.11
2	4.62	4.32
3	4.36	4.45
4	4.50	4.34
5	4.50	4.37
Average.....	4.51	4.32

The most noticeable primary effect of abortion on the quality of the milk is to make it richer than it would have been had the cow gone full time.

The milk of a cow gradually grows richer from the time she calves until she goes dry, and then after calving again it returns to about the same quality it had after the previous calf. In the case of the cow that aborts, the milk seems to have just about the same composition, one month after abortion that it would have had if the cow had kept on giving milk and safely carrying her calf. But it is particularly to be noted, that while the milk of a cow calving at full time gradually grows richer, as the months pass, the milk of these cows that aborted gradually grew poorer, until by the third month it is just about the same quality that it would have been at the third month after calving, if the cows had gone full time.

With respect to the solids not fat, the changes are not great in any case, and the general tendencies seem to be in the same directions as the changes in the amount of fat. The milk for the first two or three milkings of a cow that has aborted while giving milk, has all the characteristics of colostrum, but in not so marked a degree as would be the case had the cow gone dry and calved at full time.

In this connection it is well to call attention to the record of the cow Beauty, that calved at full time without going dry. At the time of calving she was giving 11 pounds of milk daily, testing 5.84 per cent fat. This increased after calving both in quantity and quality, to 21 pounds daily, testing 5.60. The quality dropped the following months to 5.31, 5.29 and 5.26, rising the fifth month to 5.59 per cent fat, while giving 18 pounds of milk daily. The year before, when calving at full time, after going dry, the milk tested 4.67 per cent fat. Thus, the changes both in quantity and quality of milk agreed very closely with those cows that aborted.

The principal effect of abortion is seen in its relation to the quantity of

the milk. The average yield of these cows when they went full time was 32 pounds daily, and abortion cut this down to 24 pounds per day, while five months afterward the yields are 26 pounds and 20 pounds respectively.

This great shrinkage in yield of milk after abortion makes a financial loss that every farmer can appreciate, and it is no wonder that he looks on this as one of the worst diseases that can visit his herd.

II. RECORD OF THE STATION HERD FOR THE YEAR 1892.

By W. W. COOKE.

When the Experiment Station was started, it was recognized that dairying was the leading industry of Vermont, and that therefore it should be given the most important place in the work of the Station. It was also decided that it would make the work of the Station more valuable if the herd was not of the highest priced animals, but such a herd as is within the means of most of the dairymen of the State, *i. e.* a good working dairy. Our herd as it now stands has been collected without any large outlay; indeed, the cow that has made the best record cost but sixty dollars, and only four cows in the herd have cost over one hundred dollars. We hoped to obtain good yields by good care and feed, rather than by buying costly stock.

Our first aim was to have the herd yield an average of three hundred pounds of butter apiece per year. Now that they have reached and passed that yield, we have set our mark still higher, and shall not be satisfied until they equal the records of the very best herds.

Owing to the necessities of our experimental work it is not possible to *make into butter* all of the milk produced by the cows, and we are therefore obliged to use estimates as to the yield. Each milking of each cow is weighed, and *sixteen* milkings of each cow during each month are analyzed for total solids and fat. It is certain that in this way we get a correct estimate of the amount of *butter fat* yielded by the cows. There remains the question as to how much butter shall be estimated for each hundred pounds of butter fat. The milk is handled by the separator and the cream churned sweet at a very low temperature. In this way we have very small losses in the skim milk and buttermilk, and in ordinary work can make 115 pounds butter for each 100 pounds butter fat. By using extreme care we have made 119 pounds to the 100 with the milk of a single cow, which is much more difficult than to do the same with the mixed milk of a herd. To be certainly on the safe side, all the records given hereafter are based on only 110 pounds of butter for each 100 pounds of butter fat.

During the year there was considerable shifting of cows in the herd, owing to a change of farms that threw several poor cows on our hands for a few months, but every cow is counted in the following record, good, bad and indifferent, and counted the full number of days it was on the farm, whether giving milk or not, except the heifers, which are counted from the day they came in milk.

RECORD OF THE HERD OF THE STATE AGRICULTURAL EXPERIMENT STATION
FOR THE YEAR ENDING DECEMBER 31, 1892.

Name.	Breed.	Age Jan. 1, 1892.	Days at the Farm.	Milk.	Fat.	Fat.	But- ter.	lbs. Milk to 1 lb. Butter.
		yrs. mos.		lbs.	%	lbs.	lbs.	
Regular Members of Herd								
La Violette	Jersey	2-4	366	5,587	5.41	299.3	329.2	16.8
Sadie's Delight	"	4-2	366	8,452	4.68	395.8	435.4	19.6
Marburi	"	2-4	366	5,242	4.87	255.2	280.7	18.7
Bright Eyes	"	5-	313	6,551	5.66	370.4	407.4	16.1
Lottie	"	8-	366	6,980	4.00	277.7	305.5	23.3
Dorothy	"	5-	366	5,502	4.73	260.2	286.2	19.2
Minerva	"	9-	366	4,182	5.12	214.4	235.9	17.4
Myrtle	"	6-	366	6,488	5.94	385.6	424.2	15.3
Lolita	A'yshire	5-	366	8,055	3.90	314.1	345.6	23.3
Cigarette	Holstein	9-	366	10,412	3.65	380.7	418.8	24.9
Pipchin 2d	"	11-	366	9,507	3.40	323.5	355.9	26.7
Dinah	Grade	9-	366	9,513	3.83	363.9	400.3	23.8
<i>Average per cow</i>				7,197	4.43	319.	351	20.5
Two-year olds with first calf.								
Cloverette	Holstein	1-9	266	5,911	3.37	198.6	218.5	27.0
Gretchen	Grade	1-7	203	3,971	4.56	181.0	199.1	19.9
Beauty	Jersey	2-4	273	3,967	5.37	212.7	234.0	17.0
Mercedes	Holstein	2-4	306	6,385	3.69	235.3	258.8	24.7
<i>Average per cow</i>			262	5,058	4.07	206.	227.	22.2
Cows bought during the fall.								
Rena Myrtle	A'yshire	5-	149	2,909	3.51	102.1	112.3	25.9
Creamer	Grade	8-	79	2,582	3.94	101.7	111.9	23.1
Bet	Grade	11-	82	1,804	3.42	61.6	67.8	26.6
Bonnie 2d	Grade	8-	82	1,888	3.56	67.2	73.9	25.5
<i>Average per cow</i>			97	2,295	3.61	83.	91.	25.2
Irregular Members of Herd.								
Several Cows	Grade		1965	31,800	4.30	1367	1501	21.2
<i>Total for herd</i>			7553	147,598	4.32	6373	7010	21.1
<i>Average number of cows</i>			21					
<i>Average per cow</i>				7,028	4.32	303	334	21.1
Average 6 Mature Jerseys				6,350	5.00	317	349	18.2
" 1 " Ayrshire				8,055	3.90	314	345	23.3
" 3 " Holsteins				9,810	3.60	353	388	25.3
" Best 3 Jerseys				7,130	5.39	384	422	16.9

Many of the cows have larger yearly records during the time they have been at the farm, than the record given here for the year 1892.

Some of the best are as follows :

Pipchin 2d, 10,746 lbs. milk, 405 lbs. butter in a year.

Bright Eyes, 6,726 lbs. milk, 419 lbs. butter in a year, 14.1 lbs. butter in 7 days.

Cigarette, 10,691 lbs. milk, 431 lbs. butter in a year.

Sadie's Delight, 9,004 lbs. milk, 454 lbs. butter in a year, 14.2 lbs. butter in a week.

Myrtle, 7,482 lbs. milk, 482 lbs. butter in a year.

The highest record we have ever had is that of Dinah, who has given 52 lbs. milk in a day and 12,224 lbs. milk in a year, while the butter record is 16.4 lbs. butter in 7 days, and 506 lbs. butter in a year.

There is a tendency at the present time among breeders to claim for their herds more than 110 pounds of butter for each 100 pounds of butter fat in the milk. In the great dairy breed test at Chicago, 80 per cent of butter fat in the butter has been made the standard and it has been found there quite easy to make 120 pounds of 80 per cent butter for each 100 pounds of butter fat in the milk. Judging from present tendencies it will be the ordinary method of calculation in the near future to add one-fifth to the butter fat found, to obtain the amount of butter that should be credited to the cow. Indeed this proportion has been already officially endorsed by one of the principal dairy breeds in the country.

If this method is employed on the above records it will increase them very decidedly. The record of the regular members of the herd would then become 883 pounds of butter per year. The average per cow for the whole herd would be 864 pounds of butter; while of the single cows given above, the record of Sadie's Delight would be changed to 489 pounds, of Myrtle to 521 pounds, and of the cow Dinah to 546 pounds of butter in one year.

That these cows have been liberally fed, goes without saying. The regular grain ration was eight pounds per day per cow for those in milk. This has been increased for some of the heaviest milkers and decreased for the younger stock. This grain has been mostly wheat bran and corn meal, equal parts by weight, though it has been varied greatly in the different experiments.

The cows have been stabled every night in the year, and have had what hay and corn ensilage they would eat. They were out for five months on very short pasturage.

III. RELATIVE VALUE OF A COW FOR CHEESE MAKING AND FOR BUTTER MAKING.

By W. W. COOKE.

Until within a few years the doctrine was accepted without question that some cows were better adapted for cheese making than for butter-making, while other cows gave milk so rich that it could not profitably be made into cheese, but was well adapted for butter-making. This is still largely believed, but the results obtained by Dr. L. L. Van Slyke at the Geneva Experiment Station, and still more lately the results of the cheese test in the dairy breed test at Chicago, have caused doubts to arise as to the correctness of this belief. The experiments of Dr. Van Slyke are the most extensive ever made, and the breadth of the inquiry and the care and skill with which they have been conducted, lends great weight to the conclusions.

The different cows in the Station herd show great variations in the quality of their milk; they include the Jersey, which is claimed by its friends to be the breed pre-eminent for butter; the Ayrshire that has been always claimed to be the best cheese cow known, and the Holstein that is put forward by its friends as the general purpose cow, good for both butter and cheese.

Let us study the records of the best cows of each of these breeds in the Station herd and see what the comparative results would have been had the milk of each been made into cheese instead of butter.

Breed.	Milk for a Year. lbs.	Per Cent of Total Solids.	Per Cent of Fat.	Pounds of Solids.	Pounds of Fat.
3 Jerseys.....	7,130	15.01	5.89	1,070	384
1 Ayrshire.....	8,055	12.81	3.90	1,025	314
3 Holsteins.....	9,810	12.55	3.60	1,230	353

According to the best light now attainable from Dr. Van Slyke's results, 100 pounds of the Jersey milk containing 15.01 per cent total solids, and 5.89 per cent of fat, would make 14.01 pounds of green cheese, while the Ayrshire milk with 12.81 per cent solids, and 3.90 per cent of fat would make 10.47 pounds of green cheese, and the Holstein milk with 12.55 per cent solids and 3.60 per cent fat, would make 9.70 pounds of cheese to each 100 pounds of milk. If 100 pounds of butter fat is considered as making 110 pounds of butter, the three milks would make 5.93, 4.29 and 3.96 pounds of butter, respectively, from each 100 pounds of milk.

Breed.	Milk for One Year. lbs.	PRODUCT FROM EACH 100 POUNDS OF MILK.		TOTAL PRODUCT FROM THE MILK.	
		Cheese.	Butter.	Cheese.	Butter.
		lbs.	lbs.	lbs.	lbs.
Jersey	7,130	14.01	5.98	998	422
Ayrshire....	8,055	10.47	4.29	848	345
Holstein....	9,810	9.70	3.96	952	388

If two and a half pounds of cheese are considered to be equal in market value to one pound of butter, which are fair average market conditions, then for every 100 dollars obtained from the Jersey milk made into butter, there would be received 95 dollars, if the milk had been made into cheese. In the case of the Ayrshire milk, the relation would be as 100 to 97, while the Holstein milk would give 98 dollars' worth of cheese for each 100 dollars' worth of butter.

It will thus be seen, that the thinner Holstein milk is a little better adapted to cheese-making than the richer Jersey milk, but the differences are not large. The most important fact brought out by the comparison is that *they are all good for butter and all good for cheese.*

But if that is true for these cows, it is true for nearly all cows, since the range of composition here includes the great bulk of dairy cows. The logical conclusion, then, is that the so-called "cheese-cow" *i. e.* the cow which is good especially for cheese rather than for butter, does not exist, and that wherever a cow is found that is good for cheese-making purposes, the milk of that cow is equally good for the manufacture of butter.

IV. AERATION OF MILK.

By W. W. COOKE.

The aerating of milk has been practiced for many years. Much has been claimed for it in beneficial effects, and certain results have come, by general consent, to be attributed to it. The general beliefs concerning it may be summarized as follows:

1. It is believed that aerating the milk tends to drive out any bad odors that have been absorbed by the milk.
2. It is believed that aerating milk will tend to lessen the bad taste and smell resulting from improper food, such as onions, etc.
3. It is believed that aerating the milk will cause it to produce more and better cheese.
4. It is believed that aerating the milk tends to retard the raising of the cream by ordinary processes, so that more fat will be left in the skim-milk.

5. It is believed that aerating milk makes it keep longer before it sours.

The published exact experimental data on which these general beliefs are founded, are not extensive. That the first two beliefs are correct, needs no discussion. Experimental proof of the truth of the first has been published in a previous report of this Station, and the truth of the second is well-known to all who have used aerators.

It is not proposed here to discuss the truth or falsity of the third belief. The fourth and fifth statements are the ones that have been investigated at this Station during the past six months, and it is the tests made and the results obtained that it is desired here to report.

Tests covering much the same inquiries have been published the past year by the Purdue and Cornell Stations. Prof. C. S. Plumb at Purdue University, divided several lots of milk, setting one-half without aeration in deep warm setting at 55°, while the other half was aerating with the Heulings aerator and the temperature reduced to 56° and then set with the rest. On the average the same amount of butter was obtained from both lots, and there was no special difference in the per cent of fat left in the skimmilk.

Where two lots of milk were handled under similar conditions, one aerated and the other not, there was almost no difference in their keeping qualities. Whatever difference there was seemed to be in favor of the non-aerated milk.

At Cornell University, Prof. H. H. Wing found that when milk was aerated and at the same time cooled to 40°F. and then set in a Cooley tank at 40°-44° there was 0.58 per cent of fat left in the skimmilk, as the average of four tests, while milk similarly set warm from the cows without aerating, left but 0.31 per cent of fat in the skimmilk.

Milk that was at the same time aerated and cooled, kept from four to five hours longer than that which was not aerated. Milk which was aerated by another form of machine which did not cool it, kept no longer than the non-aerated.

EFFECT OF AERATION ON THE CREAMING OF MILK.

In most of the discussions heretofore concerning the advantages or disadvantages of aeration, the distinction has not been made between aerating *with cooling* and aerating *without cooling*. The present writer has been one of the number who have failed to make this distinction and has been thereby led to attribute to aeration results which he now believes were due not to the aeration but to the cooling which took place at the time of the aeration.

We had found in previous work that when milk was aerated the cream rose less perfectly, and had considered this due to the aeration.

The present series of tests were undertaken to ascertain whether it was the aeration or the cooling which was the cause of the poor creaming.

A lot of milk was divided, one-half being set at once in the Cooley creamer in ice water. The other half was run four times over a Heuling's aerator through which luke warm water was passing, so that the temperature of the milk remained constant while it was very thoroughly aerated. Both lots of milk were of the same temperature when set side by side in the same tank, and on skimming at twenty-four hours, they both showed the same per cent of fat in the skimmilk. A second trial conducted in the same way yielded the same results. Later for seven days the milk was divided into three portions. One was set unaerated, another was aerated, using cold water so that aeration and cooling went on together, while the third portion was aerated without cooling. In each case the milk was run over the aerator several times and the water in the tank was about 45°. The results are shown below.

No. of Test.	Milk Not Aerated.		Aerated and Cooled.		Aerated Without Cooling.	
	Temperature when Set.	Per cent of Fat in Skimmilk.	Temperature when Set.	Per cent of Fat in Skimmilk.	Temperature when Set.	Per cent of Fat in Skimmilk.
1	95°	0.35	46°	0.70	95°	0.35
2	94	0.35	46	0.50	95	0.50
3	96	0.35	46	0.45	96	0.35
4	95	0.35	48	0.60	95	0.40
5	95	0.50	50	0.60	95	0.45
6	98	0.50	52	0.60	98	0.50
7	98	0.30	52	0.50	98	0.30
Average	96	0.39	49	0.56	96	0.41

The figures point very strongly to the conclusion that the aerating, though done very thoroughly, had no effect to either help or hinder the creaming of the milk, while the cooling seems just as unmistakably to have induced less perfect creaming.

These tests were made with a Heuling's aerator. Another series of tests were made with a Wood aerator in which the milk falls through the air in fine streams.

One portion of the milk was set unaerated, another portion was put through the aerator four times, in a warm room, and the third portion was aerated the same number of times outdoors in the open air. All the milk was then set in the same tank in ice water at 40°.

No. of Test.	Non-Aerated.		Aerated Outdoors.		Aerated in Warm Room	
	Temperature when Set.	Per cent. of Fat in Skimmilk.	Temperature when Set.	Per cent. of Fat in Skimmilk.	Temperature when Set.	Per cent. of Fat in Skimmilk.
1	92°	0.55	68°	0.58	86°	0.60
2	91	0.55	64	0.60	78	0.58
3	92	0.45	68	0.47	82	0.58
	92	0.52	67	0.55	82	0.59

Neither the aerating or cooling seems to have had much effect on the separation of the cream. This milk was largely from strippers, and all of the creaming is poor. Moreover the milk that was most cooled had still twenty-five or more degrees of temperature to fall after it was put in the tank. At the time the last test was made a similar portion of milk was run over the Heuling's aerator and cooled to so low a temperature that it was colder than the water in the tank, and the temperature therefore rose on setting in ice water instead of falling. When skimmed at twenty-four hours there was 1.11 per cent. of fat in the skimmilk.

These two sets of tests, combined with those from Purdue and Cornell, would seem to show that aeration, of itself, is without effect on the creaming of milk, and that the bad effects hitherto attributed to aeration are not due to it, but to the cooling which usually attends aeration.

EFFECTS OF AERATION ON THE KEEPING QUALITIES OF MILK.

The present writer is obliged to acknowledge that in regard to this phase also of the subject he had failed to make a distinction between aeration and cooling, and had consequently been led into error as to the effects of aeration itself on the keeping qualities of milk.

If we take into consideration what happens when milk sours, it will help us to see what should be expected to happen from the aeration of milk. The souring of milk is caused by the growth in the milk of countless numbers of bacteria that produce lactic acid. The only way to prevent the milk from becoming sour is not to allow bacteria to enter it, or if they have once found a home in the milk, to subject it to such conditions as to kill them. Anything which retards the rapidity of their growth will postpone the time when the milk will become sour. Under ordinary treatment it is impossible to prevent these bacteria, these lactic acid germs, from entering the milk. After they are once there the only ways to kill them are by chemicals or by heat. Subjecting the milk to cold *retards* the growth of these germs, but

does not kill them; hence if milk is kept cold enough it will be a long time before it sours; but at anything less than temperatures near to freezing, the growth of the germs will slowly progress and the milk gradually spoil.

Aeration is merely the mixing of the milk with air. There is nothing in this process that should have any effect, to check the growth of the bacteria, and since the extra manipulation and exposure makes an increased chance for more germs to enter the milk, it follows from these facts that aeration should have but little effect on the keeping qualities of the milk, and the effect, if any, would be to make it sour the more quickly.

In the light of these remarks it is easy to explain the apparently contradictory results obtained at Purdue and Cornell. The aeration at Purdue was made without cooling, and almost no effect of aeration was observed on the keeping qualities of the milk. At Cornell, when an aerator was used that did not cool the milk, no benefit was noted, but in the use of the two aerators that both aerated and *cooled* the milk, a retarding of the time of souring followed, which retardation is evidently the result, not of the aeration, but of the cooling.

The two forms of aerators already mentioned, the Heuling's and the Wood, were tested at this Station with reference to this point. To determine the time of souring and the relative degree of acidity the samples were titrated, using phenolphthalein as an indicator. It was found, however, that more satisfactory results were obtained by the aid of taste and smell than by the use of chemical means. It is not necessary to go into the details of the many tests that were made with the two aerators with cold and warm water, indoors and outdoors, and with milk kept in several different ways after aerating. It is sufficient to say that whenever the milk was aerated in such a manner that but little cooling took place during the time of aerating, it soured just as quickly as the corresponding samples not aerated. When the milk during aeration was very thoroughly cooled the time of souring was delayed, though not much, never more than one-eighth of the entire time from milking to souring.

Credit should here be given to Mr. H. I. Collins, one of our Senior agricultural students, who performed a large part of both the manipulation at the creamery and the analytical work in the laboratory described in the foregoing tests.

CONCLUSIONS.

Summing up the results obtained, the fourth and fifth beliefs given in the opening of this article can be re-stated as follows:

4. It ought to be believed that aerating milk without cooling has no effect on the creaming of that milk. But if the milk is cooled during the aeration the creaming of the milk will be less perfect.

5. It ought to be believed that aerating milk does not make it keep longer before it sours, but that cooling milk as soon as drawn from the cow will retard the time of souring.

V. ABNORMAL MILKS.

By J. L. HILLS.

The registered Holstein cow Mercedes, and the registered Ayrshire cow Lolita, both belonging to the Station herd, gave the following qualities of milks just before going dry:

	Total Solids.	Fat.	Casein.	Milk Sugar and Ash.	Solids not Fat.	Specific Gravity.
Mercedes...	17.08	5.90	6.08	5.10	11.18	1.040
Lolita.....	10.33	2.98			7.35	1.027

They were giving at the time 3.6 and 5.5 lbs. of milk daily. The average character of the milk of these animals for the five months previous was much the same, being about twelve and a half per cent. of total solids, and three and a half per cent. of fat. In going dry, the Holstein increased the richness of her milk, while the Ayrshire decreased it. Judging by gravities alone, one would be warranted in considering the rich stripper milk a skim milk, and the poor stripper milk to be watered. The gravities reported above are believed to be at the extremes of those hitherto published on genuine unadulterated milk. The solids not fat are likewise believed to be as wide apart as has hitherto been found. The analyses go to show that it is not safe to predict just what a stripper will do.

A sample of the milk (?) taken after slaughter from the udder of a three-year-old heifer, which had never had a calf, analyzed:

Total Solids.	Fat.	Casein.	Milk Sugar and Ash.
9.13	1.20	5.58	2.35

It had the appearance of skimmilk, and the quantity was small.

VI. THE EFFECT OF WEATHER UPON THE QUALITY AND QUANTITY OF MILK.

By J. L. HILLS.

The results of an investigation into the effect of weather upon the quality and quantity of milk were published in the last report of this Station (pages 65-69). The tests were made at the Shelburne creamery, from May 6 to July 24, 1891. During the first month the daily yields of thirty herds were analyzed, and during the last two months those of four herds. The

results obtained seemed to indicate a connection between temperature and the fat percentage in milk.

A second test of the same matter has been made during the past year, lasting from July 20 to September 15, 1892. The Station herd was the subject of the test, and by means of the Babcock method for determining fat, and the lactometer, the scope of the investigation was enlarged to include the total solids.

The results of both series of tests point strongly to the probability that when cows are out to pasture the per cent. of fat rises as the temperature falls, and falls as the temperature rises; or, in other words, the fat in milk varies inversely to the temperature changes. The present test indicates that this is also true of both total solids and solids not fat; that changes in temperature in either direction from normal tend to decrease the quantity of milk; and that rain storms, unless very heavy, do not seem to affect either quantity or quality to any marked degree.

We have not been able to discover any more plausible theory for this tendency of the cow's nature than the one suggested in this connection in the last report, that "during cold weather the cow actually consumes more food and thus there is present in the system a larger amount of material from which to produce richer milk."

The test upon the Station herd was divided into two parts. From July 20 to August 22, the herd was divided into four groups. One group included three Holsteins and one Ayrshire, averaging about thirty-seven pounds of milk apiece daily. The second group included two Holsteins, one Jersey, one Ayrshire and three grades, averaging twenty-two pounds of milk apiece daily. The third and fourth groups were made up of five and four Jerseys respectively, averaging twenty and fifteen pounds of milk apiece daily. The mixed milk of each group was analyzed as if it were that of a separate herd.

From August 22 to September 15, the entire herd was taken as a whole. Five or six samples of each milking were taken as the pails were brought into the creamery, analyses and weights giving by calculation the average per cent of fat in the herd milk. Total solids were calculated only in the first part of the experiment.

The morning's and night's milk were analyzed separately, there being in all 546 samples tested. A full record of the character of the weather, the temperature at 7 a. m., 1 p. m. and 7 p. m., and the amount of rainfall was kept throughout the test.

The cows were stabled at night, and fed grain and ensilage in the barn. There was no change in feeding, except the natural drying up of pasture, during the test. It is hardly to be expected that the morning's yield would show weather effect as plainly as does the night's milk. It does show, however, that during these two months the Station herd gave more and

richer milk in the morning than at night, there being but three cases when the night's milk was the richer.

EFFECT OF TEMPERATURE ON THE QUALITY OF THE MILK.

The test made in 1891, showed the effect of temperature upon the quality of the milk flow to be an inverse one, that "almost two-thirds, or exactly 61 per cent of the changes in quality were in the opposite direction to the changes in temperature." In the test made in 1892, there were fifty-five chances for comparing the effect of changing temperature upon the fat per cent in milk, and thirty-three to test the effect on the per cent of total solids. There were twenty-two cases of rising, twenty-one of falling, and twelve of stationary noon temperature. On twenty-one days the fat percentage in the night's milk changed in the opposite direction to the temperature, on eighteen it changed in the same direction, and in four cases there was no change in fat per cent where the temperature varied.

More than half (54 per cent) of the changes were in the inverse direction. During the twelve days of stationary temperature there were five cases of rising, three of falling and four of slight quality changes, there being three sharp quality variations which cannot be ascribed to temperature.

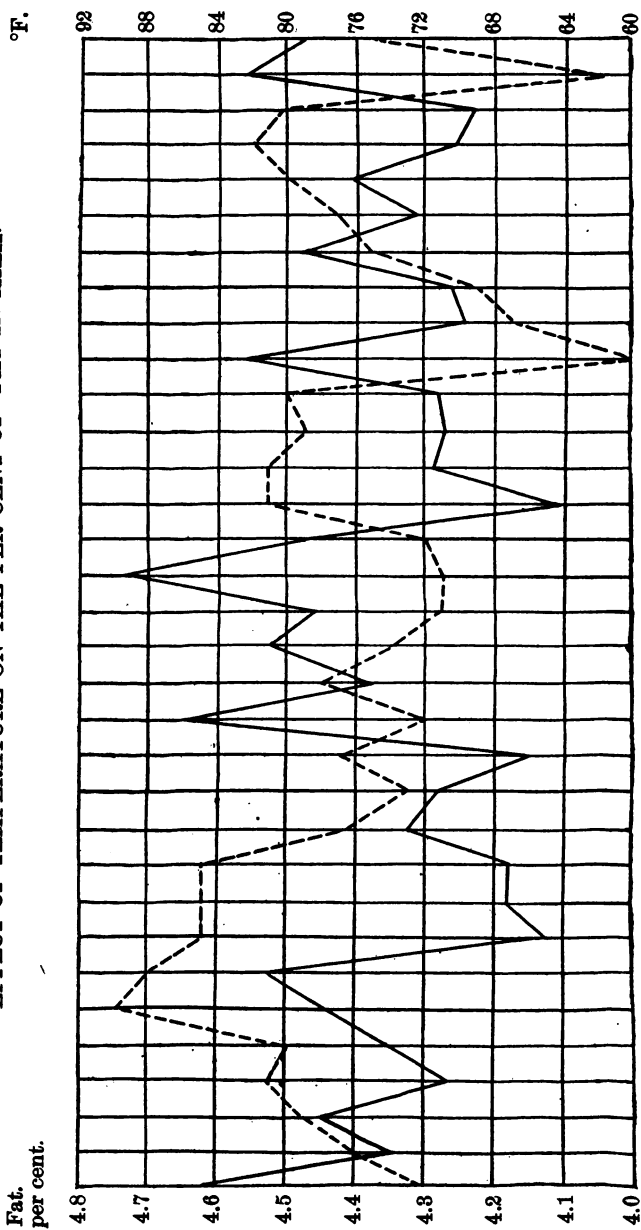
During the two months there were twelve marked changes in quality extending over a period of three or more days, in six of which the change was opposite to the temperature change, two in the same direction, and four were made during stationary or irregularly fluctuating temperatures.

The total solids were found to rise and fall in much the same way as the fat. During the thirty-three days of the first half of the test, in which the total solid calculations were made, there were fourteen days of rising, twelve of falling and seven of stationary noon temperature. On fifteen days the total solid percentage in the night's milk varied inversely to the temperature, on seven days the changes were in the same direction, and there were four cases of no change. In the seven cases of stationary temperature there were five changes in the total solids, some of them being quite sharp. A little more than two-thirds (68 per cent) of the changes were in the opposite direction to the temperature changes.

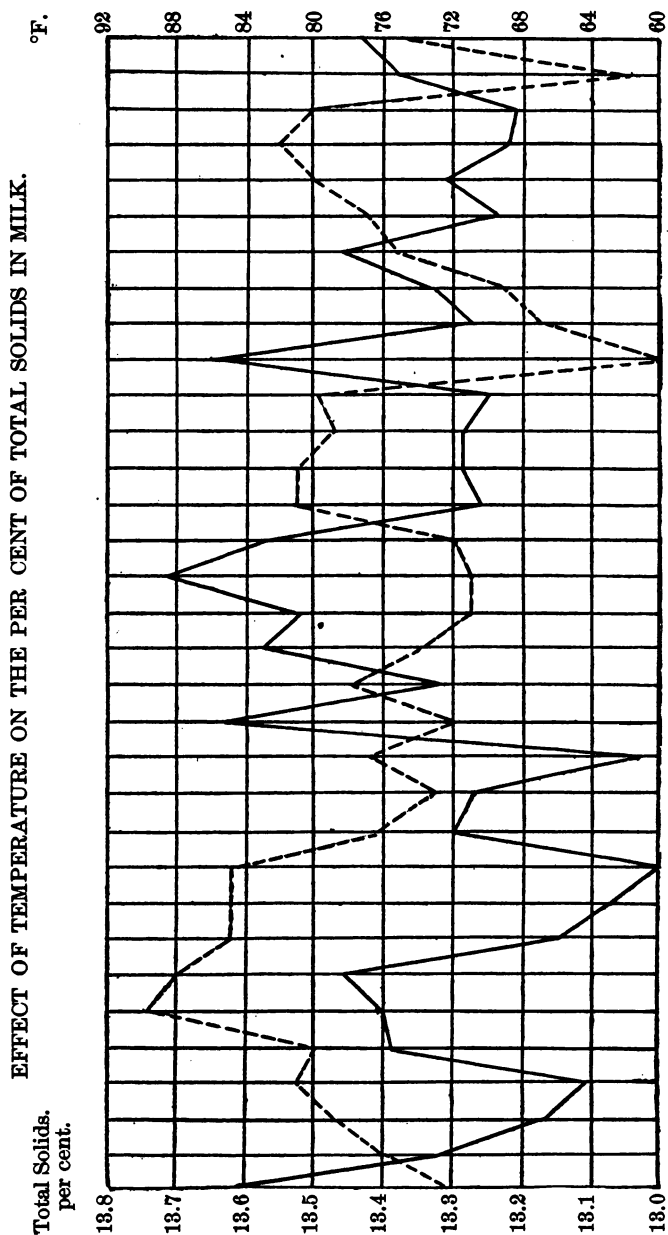
There were eleven quality changes extending over three or more days, in seven of which the change was opposite to that of the thermometer, three in accordance with it, and one was made during irregularly fluctuating temperatures.

The changes in solids not fat are usually smaller than those of total solids or fat, yet they show the same inverse tendency quite strongly. In twenty-six changes of temperature, twelve times the solids not fat change inversely, while but five times do they vary in the same direction as the thermometer. There are nine cases of 0.05 per cent change or less

EFFECT OF TEMPERATURE ON THE PER CENT OF FAT IN MILK.



The black line represents the average per cent of fat in the milk.
 The dotted line represents the noon temperature.
 Each space from left to right represents one day from July 20 to August 21.



The black line represents the average per cent of total solids in the milk.

The dotted line represents the noon temperature.

Each space from left to right represents one day from July 20 to August 21.

where there are more or less decided temperature fluctuations. Nearly three-quarters (71 per cent) of the changes are inverse ones.

It should be noticed, moreover, that the inverse changes in quality are much more decided than those in the same direction. Of the twenty-one inverse changes in the per cent of fat, but eight were less than 0.15 per cent while of the eighteen changes in the same direction but five were more than 0.15 per cent. Of the fifteen changes in the opposite direction in the total solid percentage, but three were under 0.15 per cent; while of the seven in the same direction, but one was over 0.15 per cent change. The variations in solids not fat, however, were as pronounced one way as another.

The accompanying charts show very plainly how large is the proportion of diverging lines of quality and temperature. They represent the first part of the test from July 20th to August 21st, inclusive, which is the portion when both total solids and fat were determined, and when, owing to the character of the weather, the results of the work show out most clearly.

Attention is particularly called to the low total solid and fat percentages of the seven days' hot spell at the left end of the charts, and to the fact that every time the total solids and fat exceed 13.50 and 4.55 per cents, it is coincident with a noon temperature of 72° or lower.

Attention is called to a similar chart published in the last report in connection with this phase of our work in 1891, which shows this same characteristic of the milk-flow in a very clear manner.

EFFECT OF TEMPERATURE ON THE QUANTITY OF THE MILK.

The changes in the quantity of milk during the experiment seem to bear relation to the variations in temperature in the early part of the test, but not after its change in plan. In order to show this it will be necessary to take account of the natural shrinkage. It is, therefore, assumed that such shrinkage under uniform conditions would have been constant from July 20th to August 22d, and the column in the tabulation below headed "Milk Yield, Natural Shrinkage," shows the calculated yields at the various dates under uniform conditions, using the yield of July 20-24 and August 21-22 as a basis of calculation.

The results may be tabulated as follows:

Dates.	No. of Days.	Range of Noon Temperature.	Average Weight of Night's Milk.	Average Milk Yield, Natural Shrinkage.	Actual Yield Less Than Calculated Yield.
July 20-24.....	5	72 to 81	242.5	242.5	
25-29.....	5	90 to 85	221.1	232	—11
30-Aug. 7..	9	78 to 68	204.7	214	— 9
Aug. 8-11..	4	81 to 79	206.3	206	
12-14.....	3	60 to 69	187.8	200	—12
15-19.....	3	75 to 82	187.8	190	— 2
20.....	1	62	173.7	188	—14
21-22.....	2	75 to 71	183.4	183.4	

We find sharp falls in yield in the very hot spell of July 25-29, and also in the cool days of August 12th to 14th, and on the 20th. There was a heavy, cold rain on August 12th, lasting all day. These figures would seem to indicate that temperatures other than the medium of the season, unfavorably affect the quantity of the milk-flow.

EFFECT OF STORMS.

There were several storms during the test. Quantity and quality changes which took place at the stormy periods, are shown in the following table. No account is taken of rains in which less than a tenth of an inch fell, or of rains which occurred in the night when the cows were in the barn.

There were thirteen rainy days on which more than a tenth of an inch of rain fell. On six of these days the cows gave less weight of night's milk than they had been giving in the days immediately preceding, but it tended to be a little richer; on five they gave rather more of the same quality, and on two the same weight of unchanged quality. On the seven days following the storms, four times more of the same quality of milk and three times less of poorer quality was given. The shrinkages were greater, however, after the three heavy storms than were the increases after the four medium sized rains of August 6th, 25th, 27th and September 14th, and the shrinkage in quantity overbalanced any slight gains in quality. As these heavy storms were usually accompanied by cold weather, it is an open question how much of the shrinkage to attribute to the rain.

Date.	Milk.	Total Solids.	Fat.	Solids not Fat.	Rain Fall.	TEMPERATURE.		
	lbs.	Per Cent.	Per Cent.	Per Cent.	Inches.	7 A. M.	1 P. M.	7 P. M.
July 28...	225.3	13.07	4.17	8.90	----	75	85	82
29...	211.7	13.00	4.18	8.82	1.91	76	85	79
30...	220.5	13.29	4.34	8.95	----	66	77	75
31...	201.9	13.27	4.29	8.98	0.25	66	73	67
Aug. 1...	199.4	13.04	4.15	8.89	----	67	77	77
2...	192.9	13.64	4.65	9.00	----	69	72	70
3...	212.1	13.32	4.37	8.95	----	69	78	78
4...	199.5	13.58	4.53	9.05	0.17	69	74	71
5...	203.4	13.52	4.46	9.06	----	65	71	69
6...	211.4	13.72	4.73	8.99	0.66	63	71	65
7...	201.6	13.57	4.48	9.09	----	60	72	75
8...	205.9	13.26	4.11	9.15	----	68	81	79
9...	214.1	13.29	4.29	9.00	----	70	81	81
10...	201.5	13.29	4.27	9.02	1.31	75	79	72
11...	204.9	13.24	4.28	8.96	1.18	75	80	74
12...	194.2	13.64	4.57	9.07	1.74	60	60	59
13...	186.4	13.27	4.24	9.03	----	61	67	67
14...	183.8	13.33	4.26	9.07	----	64	69	68
15...	186.4	13.46	4.48	8.98	----	64	75	70
Aug. 23...	192.	----	4.25	-----	----	62	72	69
24...	187.5	----	4.32	-----	0.67	65	71	70
25...	194.	----	4.15	-----	0.77	63	65	65
26...	192.	----	4.85	-----	0.11	63	70	69
27...	200.2	----	4.30	-----	0.52	59	61	58
28...	207.9	----	4.15	-----	----	59	68	67
29...	194.	----	4.02	-----	----	56	62	60
Sept. 6...	198.	----	4.36	-----	----	62	62	58
7...	192.7	----	4.24	-----	0.31	62	61	58
8...	201.8	----	4.33	-----	----	48	67	62
9...	193.8	----	4.30	-----	----	58	68	66
13...	199.8	----	4.28	-----	----	65	71	68
14...	201.	----	4.23	-----	0.60	68	69	67

In summing up the work of the two years, the tests may be said to show the tendency of the cow on pasturage to give richer milk when the temperature drops, and poorer milk as it rises, the quality changes extending to both fat and solids not fat. They also indicate that the milk-flow is lessened by changes in temperature away from the normal, and that a heavy rainstorm does not of necessity affect the milk-flow either in quantity or quality.

VII. TESTS OF DAIRY APPARATUS.

By J. L. HILLS.

The second session of the Dairy School of the University of Vermont was held at Burlington, from October 24th to November 19, 1892. A considerable amount of data was obtained by the Station officers during the course of the school upon the following points.

1. Relative efficiency of different makes of separators.
2. Character and amount of losses in the creamery processes, including mechanical losses.
3. Details of churning.

The school was equipped with the best apparatus obtainable. Butter workers, aerators and churns were the same as were used the previous year. There were seven separators in use, four power and three hand.

The DeLaval Belt-separator, Alpha Pattern, Acme Size, the DeLaval Steam Turbine Separator, Alpha Pattern, Acme Size, and DeLaval Hand Separators Nos. 2 and 3, were furnished by the DeLaval Separator Co. of New York city. The Imperial Belt Sharples and Russian Steam Dairy Size Separators, by P. M. Sharples, West Chester, Pa., and the United States Hand Separator, No. 5, by the Vermont Farm Machine Co., Bellows Falls, Vt. The machines were generally run in the presence of and sometimes with the help of agents of the different companies, and it is fair to suppose that they were run at their best. The power machines were set on a stone pier and run by a 12-horse power engine.

The general method of procedure during the Dairy School was as follows:

The milk came in by team at about half-past eight o'clock in the morning, and was mixed with that produced on the farm, aggregating about 1000 pounds daily. This was poured into a milk vat and warmed to the temperature desired, so that the entire mass of the milk remained at the desired temperature for quite a while before it was run through the separator. The belief was that better results could be obtained in this way than by having the body of the milk cold and interposing a warming device between the vat and the separator, so that the milk was warmed only an instant before it entered the machine. On most of the days only one separator was used, the whole thousand pounds being run through the one machine, and then the cream from that churned by itself, so that the records show the work and the results from each machine separately. On some days, however, two or more machines were used, either purposely or owing to accidents to the machinery. This renders a small portion of the records somewhat fragmentary.

The cream was caught in cans, run over the cooler, which both aerated it and brought it to any desired temperature. It was then set in the cream vat, sometimes with and sometimes without a starter, usually held for twenty-four hours, with frequent stirring, churned, washed in the granular form, salted on the worker three-quarters of an ounce to the pound, worked thoroughly and printed at once.

Samples and weights of whole milk, skimmilk, separator bowl slop, butter milk and butter were taken every day throughout the test. Generally four samples of each whole milk, always two and often more of skimmilk and buttermilk, and always two of butter, were taken and all analyzed. The results obtained by the Babcock tests were also checked by gravimetric analyses.

Thus we have the figures for calculating the amount of fat originally present in the milk, the amounts lost in the skimmilk, bowl slop, and in the buttermilk, the amount recovered in the butter, and that lost mechanically. The following tables give the most important facts concerning the handling of the milk and the cream.

It will be noted that there is considerable difference in the capacity of the various machines in amount of milk they can skim per hour, and the average figures for each will be found under the tests of each machine.

There was no test made of the power required to run the separators. It had been expected that such a test would be made, but other work intervened and prevented.

Date.	Separator.	Revolutions per Minute.	Milk per Hour. lbs.	Temperature of Milk.	Temperature of Skimmilk.	Temperature of Cream.	Per cent of Milk taken as Cream.	% Fat in Skimmilk. Timing Sample.	% Fat in Skimmilk. Composite Sample.
Oct.									
24	DeLaval Acme Belt	6200	965	83	84	83	14.9	0.07	0.13
25	DeLaval Acme Belt	6600	1205	82	83	82	14.6	0.05	0.08
26	DeLaval Turbine	6000	1770	82	83	82	12.4	0.08	0.05
27	DeLaval Turbine	5900	1840	86	86	87	12.8	0.09	0.08
28	DeLaval Turbine	6000	1850	89	90	87	12.2	0.15	0.13
29	United States No. 5, (Hand)	8000	303	84	---	---	19.6	0.25	0.09
"	DeLaval Baby No. 3, (Hand)	6700	486	84	---	---	13.1	0.16	0.15
"	DeLaval Baby No. 2, (Hand)	8000	279	84	---	---	9.5	0.08	0.05
31	Russian Steam, Dairy Size	7100	800	86	86	83	18.4	0.20	0.25
Nov.									
1	Russian Steam, Dairy Size	7200	850	84	88	81	16.5	0.21	0.20
2	Russian Steam, Dairy Size	7200	680	86	89	83	15.2	0.20	0.20
3	DeLaval Acme Belt	6300	1140	84	84	83	14.2	0.08	0.05
4	DeLaval Acme Belt and Turbine	6400	1200	78	---	80	12.7	0.10	0.10
5	DeLaval Turbine	6000	1750	83	84	81	14.1	0.08	0.06
7	DeLaval Turbine	5950	1910	85	86	84	14.8	0.06	0.06
8	DeLaval Turbine	6200	1780	84	85	82	13.6	0.07	0.08
9	DeLaval Turbine	6200	1980	86	---	---	15.5	0.10	0.10
10	DeLaval Turbine	6200	1920	84	82	85	13.4	0.05	0.06
12	DeLaval Turbine	6000	1910	82	---	---	13.5	0.12	0.10
14	DeLaval Turbine	6100	1890	80	81	82	13.1	0.07	0.09
15	Imperial Russian, Steam	---	---	84	---	---	29.8	0.42	---
"	Russian Steam, Dairy Size	---	---	84	---	---	---	0.28	0.21
16	Russian Steam, Dairy Size	7200	1030	96	96	92	34.4	0.11	0.17
17	DeLaval Turbine	6100	1870	85	82	85	13.0	0.04	0.07
18	DeLaval Turbine	5850	1930	82	84	82	15.2	0.08	0.08
19	United States No. 5, (Hand)	8500	312	90	---	---	19.	0.12	0.08
"	DeLaval Baby No. 2, (Hand)	8000	294	90	---	---	16.3	0.10	0.10

Date of Separation.	Separator.	Per cent. of Fat in					Acidity of Cream c. c. % Alkali.	Temperature at Beginning of Churning.	Temperature at End of Churning.	Time of Churning in Minutes.	Weight of Salted Butter.
		Whole Milk.	Skim milk.	Bowl Slop.	Buttermilk.	Butter.					
Oct.											
24	DeLaval Belt.....	4.66	0.10	2.29	0.22	81.35	20	56	58	15	55.2
25	DeLaval Belt.....	4.52	0.07	0.80	0.62	81.79	40	58	61	13	54.1
26	DeLaval Turbine.....	4.35	0.07	3.42	0.35	82.64	30	55	59	14	52.4
27	DeLaval Turbine.....	4.43	0.09	5.00	0.29	82.24	35	56	58	12	52
28	DeLaval Turbine.....	4.41	0.14	1.55	0.52	82.39	40	56	58	20	52
29	Hand Separators (8)....	4.18	0.12	1.05	0.24	83.67	47	56	58	72	67.4
31	Russian Steam.....	4.54	0.23	4.70	0.24	88.04	40	54	58	19	47.5
Nov											
1	Russian Steam.....	4.33	0.21	1.60	0.22	84.08	35	54	58	25	50.6
2	Russian Steam.....	4.22	0.20	0.70	0.25	81.37	33	55	58	12	48.2
3	DeLaval Belt.....	4.55	0.07	0.45	0.24	84.08	30	54	57	10	49.5
4	DeLaval Belt and Turb.	4.18	0.10	2.70	0.20	83.33	28	52	56	19	45.4
5	DeLaval Turbine.....	4.12	0.07	0.20	0.24	85.52	42	54	56	86	56.5
7	DeLaval Turbine.....	4.35	0.06	0.10	0.25	83.28	29	54	58	12	46.2
8	DeLaval Turbine.....	4.25	0.08	0.25	0.25	83.73	27	52	54	25	44.4
9	DeLaval Turbine.....	4.44	0.10	0.40	0.20	84.61	29	54	57	21	45.0
10	DeLaval Turbine.....	4.22	0.06	0.15	0.19	83.85	30	52	56	18	44.4
12	DeLaval Turbine.....	4.29	0.11	0.90	0.23	84.63	35	55	57	20	47.8
14	DeLaval Turbine.....	4.37	0.08	0.20	0.42	82.42	35	58	61	12	66.2
15	Imperial Russian.....	4.37	0.36	1.00	0.35	81.92	48	54	62	60	46.9
16	Russian Steam.....	4.36	0.13	1.20	0.35	81.72	49	58	64	75	42.4
17	DeLaval Turbine.....	3.96	0.08	0.30	0.35	83.72	33	58	60	15	30.6
18	DeLaval Turbine.....	3.99	0.08	0.20	0.41	84.13	34	58	60	14	45.5
19	Hand Machines (2).....	3.99	0.10	0.23							
	Average.....	4.31	0.13	1.27	0.30	83.16	34	54	58	31	49.5

Date.	Separator.	Per Cent of the Total Fat in			Theoretical Per Cent of Butter Fat Recovered.	Actual Per Cent of Butter Fat Re- covered.	Per Cent of Me- chanical Loss.
		Skimmilk.	Bowl Slop.	Butter- milk.			
Oct. 24.	DeLaval Belt	1.8	0.3	0.4	97.5	93.7	3.3
25.	DeLaval Belt	1.3	0.1	1.7	96.9	93.7	3.2
26.	DeLaval Turbine	1.4	0.3	0.4	97.4	93.9	3.5
27.	DeLaval Turbine	1.7	1.2	0.5	96.6	92.6	4.0
28.	DeLaval Turbine	2.8	0.3	0.9	96.0	92.8	3.2
29.	Hand Machines (3)	1.7	0.2	0.5	97.6	94.8	2.8
31.	Russian Steam	4.0	1.7	0.7	93.7	87.	6.7
Nov. 1.	Russian Steam	3.9	0.6	0.5	95.0	94.6	0.4
2.	Russian Steam	4.0	0.3	0.5	95.2	94.4	0.8
3.	DeLaval Belt	1.3	0.0	0.5	98.2	92.7	5.5
4.	DeLaval Belt & Turbine	2.2	1.2	0.4	96.2	94.2	2.0
5.	DeLaval Turbine	1.5	0.0	0.8	97.7	---	---
7.	DeLaval Turbine	1.2	0.0	0.6	98.2	95.7	2.5
8.	DeLaval Turbine	1.6	0.1	0.5	97.8	95.8	2.0
9.	DeLaval Turbine	1.9	0.1	0.5	97.5	---	---
10.	DeLaval Turbine	1.2	0.1	0.4	98.3	92.2	6.1
12.	DeLaval Turbine	2.0	0.2	0.5	97.3	97.3	0.0
14.	DeLaval Turbine	1.6	0.0	1.4	97.0	---	---
15.	Imperial Russian	4.6	0.3	1.4	94.7	91.6	3.1
16.	Russian Steam	1.9	0.4	1.7	96.0	90.1	5.9
17.	DeLaval Turbine	1.8	0.1	0.9	97.2	90.7	6.5
18.	DeLaval Turbine	1.7	0.1	1.1	97.1	---	---
19.	Hand Machines (2)	2.2	0.1	--	---	---	---
Average.	.....	2.1	0.4	0.7	96.8	93.2	3.4

The tests may be summarized as follows :

The DeLaval Acme Belt Separator was used four times. Its *skimmilk* contained 0.085 per cent fat, while running at 6400 revolutions per minute and skimming 1128 pounds of milk per hour at 82° F.

It neither warmed nor cooled the *skimmilk* or cream, took 14.1 per cent cream and left 1.65 per cent of the total fat in the *skimmilk* and 0.4 per cent of the total fat in the bowl slop. The average *buttermilk* from its creams contained 0.32 per cent fat, equivalent to 0.75 per cent of the total fat. The average mechanical loss of fat was 3.6 per cent of the total fat. *The theoretical amount of fat recovered* (i.e. had there been no mechanical losses, a character of waste which it is not always fair to credit to a separator) is 97.2 per cent, the actual, 93.6 per cent, equivalent to 121.5 and 117 pounds of butter (80 per cent fat) to 100 pounds of fat.

The DeLaval Steam Turbine Separator was used thirteen times with an average record as follows: Revolutions per minute, 6100; pounds of milk per hour, 1867, at 84°F; fat in *skimmilk*, 0.086 per cent. It neither warmed

nor cooled either skimmilk or cream, took 13.6 per cent cream, and left in skimmilk, bowl slop and buttermilk, 1.75 per cent, 0.3 per cent and 0.7 per cent of the total fat respectively; 0.30 per cent fat in buttermilk. Average mechanical loss, 3.3 per cent of total fat; *theoretical amount of fat recovered in the butter, 97.3 per cent, actual 94 per cent, equivalent to 121.6 and 117.5 pounds of butter (80 per cent fat) to 100 pounds fat.*

The *Russian Steam Separator, Dairy Size*, was used five times with average record as follows: Revolutions per minute, 7200; pounds of milk per hour, 840 at 88°F; *fat in skimmilk, 0.204 per cent.* It warmed the skimmilk two degrees and cooled the cream three degrees; took 22.9 per cent cream, and left in skimmilk, bowl slop and buttermilk, 3.7 per cent, 0.7 per cent and 1. per cent of the total fat respectively, and there was 0.28 per cent fat in the buttermilks. Average mechanical loss, 3.4 per cent of total fat; *theoretical amount of fat saved in the butter, 94.9 per cent, actual 91.5 per cent, equivalent to 118.6 and 114.4 pounds of butter (80 per cent fat) to 100 pounds of fat.*

The Imperial Sharples Russian Separator was run once. It failed to arrive until the session was nearly over and became disabled before its first run was half completed. The fragmentary record we possess is simply a single sample of skimmilk, 0.42 per cent. It is but fair to say, however, that after events showed that the machine was not at its best.

The three hand separators were frequently used on small batches of milk, and the skimmilks analyzed, but not recorded in the tabulations.

The averages are:

United States, No. 5, 4 samples 0.09 per cent fat.

DeLaval Baby, No. 3, 6 " 0.12 " " "

DeLaval Baby, No. 2, 2 " 0.06 " " "

It is but fair to say that further and more extended trial of the Baby, No. 3, after the school was over, lowered the average per cent of fat in the skimmilk a few hundredths. The bowl slops of the United States Separator were thinner than those from the DeLaval machines.

There were two regular runs of the hand separators.

The *United States Hand Separator, No. 5*, made the following average record: Velocity, 8,300, milk per hour, 308 pounds at 87°; *fat in skimmilk, 0.10 per cent; took 19.3 per cent cream.*

The *DeLaval Baby Hand Separator, No. 3*, in one trial revolved 6,700 times per minute, skimmed 486 pounds milk per hour at 84° F., took 13.1 per cent cream, and the *skimmilk contained 0.15 per cent fat.*

The *DeLaval Baby Hand Separator, No. 2*, in two trials revolved 8,000 times, skimmed 287 pounds milk per hour at 87° F., took 12.9 per cent cream and the *skimmilk contained 0.08 per cent fat.* The handling and churning of the cream from the hand separators was fully equal to that of the products of the power machines.

One of the new additions to the Dairy School equipment, a steam Babcock testing machine, tended to raise the fat percentage over those often reported. If the Babcock method has any wrong tendency it is towards giving low results, and the use of the steam machine largely overcomes this tendency. There were two kinds in use at the school, made by Moseley & Stoddard of Rutland, Vt., and by the Vermont Farm Machine Co. of Bellows Falls. The essential idea of both is that the bottles are whirled by the direct action of a jet of steam without requiring an engine. The steam not only whirls but heats the tests and keeps them hot. This does away with the use of warm water, allows the work to be done in a cold as well as in a warm room, to be done slowly as well as quickly, and even allows the completing of the analysis at any time after the acid is added to the milk. The steam machine is easier to use than a hand machine and will be found to give more accurate results, especially on thin skimmilks and buttermilks.

If we study the tables presented in this article we will note that the *mechanical losses outweigh the entire loss in skimmilk, bowl slop and buttermilk, eleven out of nineteen times*. These large losses are due to the conditions of student labor. On the amounts of milk used the average unavoidable mechanical loss ought not to exceed two per cent. It is probable that with fewer persons handling the milk and its products, less loss of this character would have taken place; but on the other hand the primary object of the school would have been defeated.

The large percentage losses in the bowl slop in the earlier part of the session, and the smaller ones later, when the use of water instead of skim-milk to rinse out the bowl while still running was resorted to, should be noted.

Among the factors which tend toward exhaustive churning, are low temperatures and thick cream.

The following summary shows the connection between temperature and churning:

No. of Tests.	Churning Temperature.	Time of Churning in Minutes	Per cent Fat in Buttermilk.	Per cent of Total Fat in Buttermilk.	Per cent Fat in Butter.
5	54 to 56	44	0.22	0.52	84.02
11	57 and 58	16	0.26	0.55	83.17
5	59 to 61	13	0.43	1.10	82.94
2	62 and 64	68	0.35	1.55	81.82

The cooler temperatures caused less loss of fat in churning, but it took longer to churn. The long churning at 62-64° was caused by enormous bulks of exceedingly thin and over-acid creams. Attention is particularly

directed to the relation between temperature of churning and the amount of butter fat in the butter. The lower the churning temperature the richer and the firmer is the butter. The butters made during the school session varied from 81.35 to 85.52 per cent of fat.

VIII. FEEDING TESTS WITH BY-PRODUCTS OF CORN.

By W. W. COOKE.

During the last few years several waste products from corn have come into the market for cattle feed. They all contain less starch than does corn, and more of the other portions. They are richer than corn meal in the albuminoids, or "flesh formers," as they are called, and some of them are remarkably rich in fat or oil. It is claimed by the manufacturers that they are more valuable for feed, pound for pound, than corn meal.

Three of these by-products have been tested by us as feeds for milch cows, and some others have been examined in the laboratory. Their composition can be seen from the analyses given in the following table, which contains also for comparison the average analyses of corn meal, of wheat bran, and of a mixture of equal parts by weight of meal and bran.

ANALYSES OF MATERIALS FED.

Fodder.	Water.	Fat.	Starch, etc.	Albuminoids.	Fibre.	Ash.	Nutritive Ratio.
Cream Gluten Meal.....	8.09	16.15	32.81	38.40	3.34	1.21	1:2
Corn Germ Feed.....	7.80	15.28	49.32	12.19	14.43	0.98	1:3.4
Buffalo Gluten Meal.....	7.83	9.95	52.78	21.81	6.65	0.98	1:3.9
Corn Meal.....	15.58	3.85	68.12	9.13	1.89	1.43	1:3.7
Wheat Bran.....	12.52	3.53	53.94	15.02	9.31	5.68	1:4.8
One-half Corn Meal, one-half Bran	14.05	3.69	61.03	12.08	5.60	3.55	1:6.3

These feeds all come from the glucose works, where glucose sugar or syrup is made from corn. The three mills, that of the Chas. Pope Glucose Company, the Chicago Sugar Refining Company and the American Glucose Company, represent most of the glucose made in this country. It is on the product of these mills that the farmers must depend if they desire to make use of these new and concentrated cattle feeds.

The early stages of the process are quite similar in the three mills. The whole corn is soaked in water for many hours, until it is much swollen and

thoroughly softened. It is then run through stones set quite a distance apart, which rubs off the husk and the germ and at the same time beats up the starch and the gluten. The mass is then sifted through very fine bolting cloth, the starch and gluten going through together, the husk and the germ remaining behind. In the works of the Chas. Pope Glucose Company these latter are dried and go on the market as the Corn Germ Feed mentioned above. In the Chicago Sugar Refining Company the germs are treated to extract part of the oil, which goes on the market as a very fine, clear "maize oil, and the remainder is sold as cattle feed under the name of Chicago Maize Feed.* The starch and gluten that have passed through the bolting cloth are separated by running into large tanks and settling, the starch as the heavier settling to the bottom, and the gluten, being lighter, running off from the top. As will be seen by the analysis, it is not possible to separate them perfectly, the gluten still containing one-third its weight of starch. In the Chas. Pope Glucose Company this separated gluten is dried, and comes on the market as the Cream Gluten Meal. In the Chicago Sugar Refining Company part of the oil is taken out for maize oil, and the remainder goes on the market as the Chicago Gluten Meal.

The process used by the American Glucose Company is similar to that outlined above, but the gluten meal is mixed with the husks and germs without extracting anything from either, and the whole goes on the market as the Buffalo Gluten Feed given above.

After this mechanical separation has been made and the starch entirely separated, this starch is then acted on by the various chemicals needed to change it to glucose. None of these chemicals are used until after the part which is to be sold as cattle feed has been entirely removed. Thus it is not possible that the sulphuric acid used in the manufacture can by any means get into the by-products or come in contact with the cattle feeds. There is nothing whatever in these feeds except what was contained in the original whole corn, and there is, therefore, no reason from their composition why they should not be easily digestible and perfectly healthy.

The several mills all together grind about sixty thousand bushels of corn a day, and produce about four hundred tons of by-product for cattle food. Though this amount seems large in itself, yet when compared with the quantities of grain used daily by the dairy farmers of this country, especially during the winter months, it is but a drop in the bucket. As the high feeding value of these by-products becomes better known it is probable that the demand for them will materially raise the present low prices.

The Cream Gluten Meal and Corn Germ Feed mentioned in the following experiments were obtained partly in open market and partly from the Eastern selling agent, W. E. Dennis of Boston, Mass. The Buffalo Gluten Feed was obtained partly from the open market, and partly from the East-

*For analysis see page 85.

ern agents of the American Glucose Company, Chas. M. Cox & Co. of Boston, Mass.

Quite a number of experiments have been made with these by-products at the Station during the past three years. In some of these the by-product has been tested as to its feeding value compared with corn meal, and in others with relation to its feeding value as compared with equal parts by weight of wheat bran and corn meal.

The first experiment to be detailed was conducted with nine cows, and lasted four months, from February 23d to June 14th, 1892. The cows were fed two pounds of cornmeal and two pounds of wheat bran daily, and four pounds of the particular grain under experiment. At the end of four weeks the feed was changed to four pounds corn meal and four pounds bran, to be again changed to the experimental grain at the end of another four weeks, and later changed again to the bran and corn meal.

Thus each grain was compared with the standard bran and corn meal, and through that with each other. This mixture of bran and corn meal was taken as the standard because it is itself a good, well-balanced feed. It is also largely used, is very uniform in composition and feeding value, and can easily be obtained at all times for future comparison of other feeding stuffs:

FEEDING RECORDS.

Cows.	Feb. 23 to March 23.	March 22 to April 19.	April 19 to May 17.	May 17 to June 14.
La Violette....	Gluten feed..	Bran and corn	Gluten feed..	Bran and corn
Sadie's Delight	Gluten feed..	Bran and corn	Gluten feed..	Bran and corn
Mercedes	Bran and corn	Gluten feed..	Bran and corn	Gluten feed..
Marburi	Germ feed....	Bran and corn	Germ feed....	Bran and corn
Bread Loaf....	Germ feed....	Bran and corn	Germ feed....	Bran and corn
Rosaidie.....	Bran and corn	Germ feed....	Bran and corn	Germ feed....
Cigarette.....	Cream gluten.	Bran and corn	Cream gluten.	Bran and corn
Myrtle.....	Cream gluten.	Bran and corn	Cream gluten.	Bran and corn
Dorothy.....	Bran and corn	Cream gluten.	Bran and corn	Cream gluten.

The rest of the ration was alike for all of the cows, and consisted of 8 pounds of cut hay and whatever corn ensilage they would eat. The day's feed was given in two equal parts, night and morning. The bran and corn were always eaten, but the three experimental meals were not well liked and nearly always some was left, so that the comparison is not strictly accurate. The cows were eating a little less grain per day when on experimental grains than when on bran and corn. So that when we find they did better on the experimental grains than on the bran and corn, we are justified in saying that the experimental grains have even a higher feeding value than the high figures to be given would seem to indicate.

The first ten days of each feeding period was considered as preparatory, then samples were taken for analysis of the milk for the next six days; then the next six days were omitted and samples again taken for the last six days. The milk of the middle six days was weighed and it was considered to have the same composition as the average of the six days preceding and following. In the middle of the third period the cows all went out to poor pasturage, but they still ate about the same at the barn as they had before, the pasturage seeming to take the place of part of the ensilage. It is believed that this change did not seriously interfere with the experiment, nor alter the conclusions drawn, though it may have slightly modified the figures expressing the effect of the different feeds. This point was checked by control tests with other cows and the above conclusions reached.

CREAM GLUTEN MEAL.

Two cows had cream gluten during the first and third period, and bran and corn during the second. The average of the first and third period then may be considered as what the cows would have yielded during the second period if they had been given cream gluten. A comparison of this average with what was actually yielded on the bran and corn will show the relative value of the two feeds. The average of the second and fourth periods can also be compared with the third period and obtain a second comparison of the same feeds. Thus two comparisons can be obtained with each of the three cows, or six comparisons of the relative feeding value of the cream gluten meal and the mixture of bran and corn meal.

Cow.	March 4-22.			April 1-19.			April 29 to May 17.			May 17 to June 14.		
	Pounds Milk.	Per cent Fat.	Pounds Fat.	Pounds Milk.	Per cent Fat.	Pounds Fat.	Pounds Milk.	Per cent Fat.	Pounds Fat.	Pounds Milk.	Per cent Fat.	Pounds Fat.
Myrtle	363	6.28	22.8	297	5.71	17.0	328	6.40	21.0	372	5.79	21.6
Cigarette	681	3.65	24.9	568	3.40	19.3	604	3.59	21.7	537	3.58	19.2
Dorothy	556	3.91	21.8	432	4.69	20.3	352	4.82	17.0	439	4.82	21.2

	Myrtle.			Cigarette.			Dorothy.		
	Pounds Milk.	Per cent Fat.	Pounds Fat.	Pounds Milk.	Per cent Fat.	Pounds Fat.	Pounds Milk.	Per cent Fat.	Pounds Fat.
Average two cream gluten periods....	346	6.34	21.9	643	3.63	23.3	436	4.76	20.8
Intervening bran and corn period....	297	5.71	17.0	568	3.40	19.3	352	4.82	17.0
Difference in favor of cream gluten ..	49	0.63	4.9	75	0.23	4.0	84	-0.06	3.8
Average of two bran and corn periods	335	5.75	19.3	553	3.49	19.3	453	4.37	19.4
Intervening cream gluten period	328	6.40	21.0	604	3.59	21.7	432	4.69	20.3
Difference in favor of cream gluten ..	-7	0.65	1.7	51	0.10	2.4	-21	0.32	0.9

DIFFERENCES IN FAVOR OF CREAM GLUTEN.

	Pounds Milk.	Per cent Fat.	Pounds Fat.
Total six trials.....	231	----	17.7
Average.....	39	0.31	2.9
Average per cent of change.....	8.	7.	15.

These results speak strongly in favor of the high feeding value of cream gluten meal. Two of the cows ate it quite well; the other, Dorothy, left a good deal of it, but in spite of this the cream gluten produces more milk than the bran and corn in four cases out of six, making a richer milk five times out of six, and yields more butter fat every time. The milk increases about one-twelfth, the richness of the milk increases a third of one per cent, and the net gain is about one-sixth of the total fat.

In the experiment just detailed, the cream gluten meal was compared with equal parts, by weight, of wheat bran and corn meal. Previous to this some tests had been made in which the cream gluten meal took the place of an equal weight of wheat bran.

Twelve cows were selected that had been having for many weeks eight pounds of grain a day, consisting entirely of wheat bran. Four pounds of cream gluten meal were fed in place of four pounds of the bran. Samples of the milk were taken for the four days before the change, and for the four days after the change. The effect was quite decided. Out of the twelve cows, eleven increased in quantity of milk, and one decreased; eight of the cows increased in the quality of the milk, three decreased in the quality, while one was unaffected.

It was not possible to follow nine of these cows in the quality of their milk for the rest of the winter, but the quantity was noted, and they continued to give largely, although it was found necessary to cut down on the quantity of cream gluten meal and give much less than the four pounds, owing to its being so rich. The other three cows were watched for both quantity and quality, and when tested three weeks after the cream gluten meal feeding begun, one was giving more milk, one less, and one the same, while all three were giving a poorer quality of milk than they had before the cream gluten meal feeding began. In the light of subsequent experiments with this feed, there is little doubt but that all of these cows were over-fed, and the results should have but little weight in determining the relative feeding value, though they show how easy it is to feed too much of a good feed.

In the third series of tests the cream gluten meal was compared with an equal weight of corn meal. The tests were made with a herd of sixteen cows, which had been having a ration of four pounds of bran and four pounds of corn meal daily. Three pounds of cream gluten meal was put in the place of three pounds of corn meal, the bran remaining the same. This mixture was fed to eleven of the cows, while the other five continued to eat the mixed bran and corn meal. At the end of thirty days the cows having the cream gluten meal had shrunk 15 per cent in milk, had gained very slightly in per cent of fat, and had shrunk 15 per cent in pounds of fat. The five other cows on the unchanged rations had made just the same variation in the quality of the milk, and had shrunk 20 per cent in quantity of milk and in pounds of fat, giving, therefore, an advantage of 5 per cent in favor of the cream gluten meal on the quantity of the milk, and no effect on the quality.

During the next winter five further tests were made with this feed, with three different cows, comparing it with equal weights of corn meal. In each of these five cases the cow was fed four weeks on the mixture of bran and corn meal, then changed for four weeks to bran and cream gluten meal, then changed back again to the bran and corn meal; or else two cream gluten meal feeding periods were separated by four weeks on bran and corn meal. In either case the average of the first and third periods is compared with the second period. In these five tests there was a gain in quantity of milk every time from the feeding of the cream gluten meal, averaging, a little more than two pounds per day, or one-eleventh of the total quantity given. At the same time there was a decrease in the quality of the milk in every one of the five cases, the decrease on the average being 0.28 per cent of fat, or one-fourteenth of the milk yield. The increase in the quantity being more than the decrease in the quality, there was, therefore, an increase in the pounds of fat given, amounting to about one-twenty-fifth of the entire product.

Recapitulating these four experiments, the results would seem to show that the cream gluten meal certainly has a high feeding value; that it is decidedly better than the mixture of equal parts of wheat bran and corn meal; that it is also better, pound for pound, than the clear corn meal, so far as both quantity of milk is concerned and quantity of butter fat. In regard to its effect on the quality of the milk, the results are contradictory, in some cases quality being apparently enriched from the use of cream gluten meal, in other cases just as decidedly made thinner. It is also to be noticed that in some cases the same individual cows at one time gave a richer milk from the cream gluten meal, while at another time they gave a thinner milk.

It must always be borne in mind in feeding cream gluten meal that it is an exceedingly rich, concentrated food, with a large amount of oil, and is so rich it may easily clog the system, especially the liver, and produce sickness. Two pounds per day per animal should be considered the extreme limit, and less would probably be safer.

BUFFALO GLUTEN FEED.

The method of manufacture of this new cattle food has already been given, as well as the general outline of the series of tests in which it was used in comparison with equal parts by weight of wheat bran and corn meal.

The records of the tests are as follows:

MILK RECORDS.

Cow.	March 4-22.			April 1-19.			April 29 to May 17.			May 27 to June 14.		
	Pounds Milk.	Per cent Fat.	Pounds Fat.	Pounds Milk.	Per cent Fat.	Pounds Fat.	Pounds Milk.	Per cent Fat.	Pounds Fat.	Pounds Milk.	Per cent Fat.	Pounds Fat.
La Violette.....	269	5.17	13.9	242	5.25	12.7	306	5.46	16.7	322	5.32	17.2
Sadie's Delight.....	473	4.46	21.1	378	4.72	17.9	479	4.93	23.6	505	4.80	24.3
Mercedes.....	444	3.01	13.4	430	3.40	14.6	405	3.42	13.9	*	*	

*Sick.

	La Violette.			Sadie's Delight.			Mercedes.		
	Pounds Milk.	Per cent Fat.	Pounds Fat.	Pounds Milk.	Per cent Fat.	Pounds Fat.	Pounds Milk.	Per cent Fat.	Pounds Fat.
Average two gluten feed periods.....	288	5.32	15.3	476	4.70	22.4			
Intervening corn and bran period.....	242	5.25	12.7	378	4.72	17.9	*		
Difference in favor of gluten feed.....	46	0.07	2.6	98	-.02	4.5			
Average two bran and corn periods....	282	5.30	15.0	442	4.76	21.1	425	8.22	13.7
Intervening gluten feed period.....	306	5.46	16.7	479	4.98	23.6	430	8.40	14.6
Difference in favor of gluten feed.....	24	0.16	1.7	37	0.17	2.5	5	0.18	0.9

*Sick.

DIFFERENCES IN FAVOR OF BUFFALO GLUTEN FEED.

	Pounds Milk.	Per cent Fat.	Pounds Fat.
Total, five trials.....	210	----	12.2
Average.....	42	0.11	2.4
Average per cent of change.....	11	2	14.

The above figures show that notwithstanding the fact that the gluten feed was not eaten in so large quantities as the bran and corn, and the further fact that what effect the change to pasture had was against the gluten feed, yet it gave better returns than the bran and corn. In the five trials it produced more milk and more pounds of fat every time, and a richer milk four times out of five, producing one-ninth more milk, one-fiftieth richer milk and one-seventh more butter.

In the preceding test the gluten feed has been compared with a mixture of bran and corn meal. In the next test it was compared pound for pound with corn meal. It was fed for a single month to eleven cows, following a month's feeding of cream gluten meal. During this month there was no change in quantity from what the cows had been giving the month before, and only a slight change in quality. Five other cows which had no change of feed, at the same time, under the same conditions, made exactly the same changes both in quantity and quality, so that the figures would thus far indicate an equivalent value of cream gluten meal and Buffalo gluten feed.

During the following season twelve tests of Buffalo gluten feed were made with nine different cows, at various times from January to July, both in the barn and on pasture. In each case three pounds of the gluten feed took the place of three pounds of corn meal, the rest of the feed remaining the same, and consisting of wheat bran and corn meal. The gluten feed

was fed alternate months, and the average of two months compared with the month between. *Out of the twelve trials there was a gain in quantity of milk ten time, a loss twice; a gain in the per cent of fat ten times, a loss once, and no change once; a gain in the quantity of fat in eleven cases, and a loss once.* The total gain in quantity of milk amounted to one-sixteenth, in the per cent of fat to one-fiftieth, and in the quantity of fat to one-twelfth.

CORN GERM FEED.

Reference to the analysis of this feed will show that it has more "fibre" than either of the other two, being in this respect much like wheat bran, though unlike bran or corn meal, it is very rich in fat.

MILK RECORDS.

Cow.	March 4-22.			April 1-19.			April 29 to May 17.			May 27 to June 14.		
	Pounds Milk.	Per cent Fat.	Pounds Fat.	Pounds Milk.	Per cent Fat.	Pounds Fat.	Pounds Milk.	Per cent Fat.	Pounds Fat.	Pounds Milk.	Per cent Fat.	Pounds Fat.
Marburi.....	195	5.00	9.8	214	4.56	9.8	192	5.42	10.4	226	5.22	11.8
Bread Loaf.....	176	5.73	10.1	176	5.41	9.5	185	5.52	10.2	202	5.75	11.6
Rosaide.....	380	2.92	11.1	295	3.06	9.0	298	2.96	8.8	325	3.28	10.7

	Marburi.			Bread Loaf.			Rosaide.		
	Pounds Milk.	Per cent Fat.	Pounds Fat.	Pounds Milk.	Per cent Fat.	Pounds Fat.	Pounds Milk.	Per cent Fat.	Pounds Fat.
Average two germ feed periods.....	194	5.20	10.1	181	5.63	10.2	310	3.17	9.9
Intervening bran and corn period.....	214	4.56	9.8	176	5.41	9.5	298	2.96	8.8
Difference in favor of germ feed.....	-20	0.65	1.3	5	.22	0.7	12	0.21	1.1
Average two bran and corn periods.....	220	4.89	10.8	189	5.58	10.6	339	2.95	10.0
Intervening germ feed period.....	192	5.42	10.4	185	5.52	10.2	295	3.05	9.0
Difference in favor of germ feed.....	-28	0.53	-0.4	-4	-.06	-0.4	-44	0.11	-1.0

DIFFERENCES IN FAVOR OF GERM FEED.

	Pounds Milk.	Per cent Fat.	Pounds Fat.
Total, six trials.....	—88	---	1.80
Average.....	—14	0.28	0.22
Average per cent of change.....	— 9	6	2

In other words, the germ feed has been followed by a decrease of milk, an increase of richness, and but slight change in the total amount of fat.

It has then considerable less feeding value than the cream gluten meal and the gluten feed, as one would naturally expect from its composition and market price. It has apparently about the same feeding value, pound for pound, as the mixture of bran and corn, and as it can be purchased in the market for less than either of these, it follows that it should be an economical and profitable feed.

EFFECT ON THE TOTAL SOLIDS OF THE MILK.

The question arises, whether this increase of fat, due to a change of food, was accompanied by a corresponding increase of the other solid ingredients of the milk. The analyses made enable us to test this matter, and there seems to have been but little change in the other ingredients.

When eating the bran and corn meal, the four cows, LaViolette, Sadie's Delight, Myrtle and Cigarette gave milk in which there was 1.98 pounds solids not fat for each pound of fat, but when on cream gluten meal and gluten feed the milk contained 1.84 pounds solids not fat, for each pound of fat. This seemed to come from a decrease of solids not fat in per cent as well as an increase of per cent of fat. On bran and corn the solids not fat of these four cows was 9.52 per cent, and on the by-products it was 9.28 per cent.

The records of all the cows together show an average on bran and corn: Total solids, 13.90; fat, 4.70; solids not fat, 9.20. On waste products: Total solids, 13.90; fat, 4.84; solids not fat, 9.06; ratio of fat to solids not fat on bran and corn, 1:1.96; ratio of fat to solids not fat on waste products, 1:1.87.

In other words, the total solids remained on the average the same, whatever the fat increased being balanced by a corresponding decrease of solids not fat, making the proportion of solids not fat higher absolutely and relatively with bran and corn than with waste products.

SUMMARY.

In all, there were seventeen trials of single cows, in which the corn products were compared with bran and corn meal, and the total results are as follows:

The waste corn products, cream gluten meal, gluten feed and corn germ feed produced more milk than the standard ration of wheat bran and corn meal, in eleven cases out of seventeen. They produced a richer milk in fourteen cases out of seventeen, and a larger total product of butter fat in fourteen cases out of seventeen.

The cream gluten meal and the gluten feed together produced more milk in nine cases out of eleven, richer milk in nine cases out of eleven, and more total product of butter fat in every one of the eleven trials. The increase of milk averaged nine per cent, the increase of richness averaged one-fifth of a pound of butter fat for each 100 pounds of milk, while the total butter product increased an average of fourteen per cent, or about one-seventh more butter produced by the use of four pounds daily per cow of the by-products over what was obtained by an equal weight of bran and corn meal.

Hence we are led to the conclusion that germ feed has about the same feeding value as a mixture of bran and corn meal, and that Buffalo gluten feed and cream gluten meal have a higher feeding value than either the germ feed or the mixture.

In the same way the experiments may be combined in which these by-products were compared with corn meal as to their relative feeding value. There were nineteen tests of the two materials, cream gluten meal and Buffalo gluten feed. In seventeen cases there was a gain in quantity of milk, in two cases a shrinkage; ten times an increase of richness in the milk, no change three times and a decrease six times; in only three cases was there a loss in quantity of butter fat, while there was a gain in sixteen cases.

These figures show that the feeding value of these by-products is greater pound for pound than that of corn meal. They also show a general tendency of these feeds to produce a richer milk, though the fact that there are so many exceptions and that the same cow at different times gives different results, would seem to indicate that the individuality of the cow is the leading factor in the result. Though these figures are additional data bearing on the question as to whether it is possible to feed fat into milk, they cannot be said to give a decisive affirmative answer.

IX. OAT FEED.

By W. W. COOKE.

For a single month the cows were fed upon oat feed, a new refuse product from the oat-meal mills, which had never been tried at the Station before. The analysis of this new feed is given below, and, for comparison,

the analysis of wheat bran, corn meal and a mixture of these latter. From its chemical composition oat feed would seem to be not much different from a mixture of equal parts by weight of wheat bran and corn meal.

Material.	Water.	Fat.	Starch, etc.	Albuminoids.	Fiber.	Ash.	Nutritive Ratio.
Oat Feed.....	11.17	4.24	65.79	11.38	5.17	2.25	1 : 6.3
Corn Meal.....	15.58	3.85	68.12	9.13	1.89	1.43	1 : 8.7
Wheat Bran.....	12.52	3.53	53.94	15.02	9.31	5.68	1 : 4.8
$\frac{1}{4}$ Corn Meal, {	14.05	3.69	61.03	12.08	5.60	3.55	1 : 6.3
$\frac{1}{4}$ Wheat Bran, {							

The cows did not like the oat feed so well as the other feeds. They shrank decidedly in milk flow, but as other cows of the herd which did not receive the oat feed shrank equally, or a trifle more, it is probable that the shrinkage was due to the cold weather, since this was the last of September, and not to a change in feed, and that there is about an equal feeding value in the oat feed as in the other feeds. When the cows were changed the 20th of October to a mixture of wheat bran and corn meal, the shrinkage continued, and was undoubtedly due to the cold weather rather than feed. The ratio of shrinkage was just the same for the cows that were changed from oat feed to bran and corn meal as for those that had had bran and corn meal during both periods. This would indicate for the oat feed a feeding value just about equal to the mixture of equal parts by weight of bran and corn meal.

X. RELATIVE VALUE OF CORN ENSILAGE AND FRESH FODDER CORN.

BY W. W. COOKE.

During the fall of 1892 there were twenty cows at the Station barn. All of these were being fed, in addition to hay and grain, whatever ensilage they would eat once a day. During the early part of September, when the corn in the field was well grown, part of the cows were fed this green fodder corn, while the rest of the cows continued on the ensilage. The cows ate the fodder corn greedily, but did not do so well upon it as on the ensilage. The shrinkage was not large, but was enough so that the feeding

was dropped at the end of two weeks. When returned to ensilage they seemed to like it fully as well as they had the fodder corn; indeed, if anything they ate it more completely than they had the fodder corn. As between whole fodder corn and cut ensilage, they seemed to prefer the ensilage, but as between cut fodder corn and cut ensilage they preferred the fodder corn.

The above is the record of eleven cows. At the same time there were nine other cows who had the ensilage continuously. During the time when the other cows were eating fodder corn and shrinking five per cent. in the amount of butter yielded, these nine cows eating ensilage gained eight per cent. in butter yield, so that the apparent advantage in favor of the ensilage is quite decided. Unfortunately, this was not a strict comparison, since the fodder corn was from the crop of 1892, while the ensilage was from that of 1891, and the latter crop had a larger proportion of ears than the former. But the experiment has value in showing that ensilage is a first-class feed, and that it can be held over and used as a supplementary feed or soiling crop during the succeeding summer, and even into the fall. It is probable, all things taken into consideration, that this makes a cheaper soiling crop in this State than any that can be raised and fed green from the field. Even as compared with feeding the fodder corn cut green, for a small herd, it is cheaper, or at least as cheap, to cut the fodder corn in quantity, put in the silo and feed daily from the silo. There being also an added advantage of the silo, that the corn crop can be left until it has reached its best and thus obtain a larger yield per acre than would be obtained if the corn was cut immature in August and September to supply immediate needs.

XI. THE CHANGE FROM BARN TO PASTURE.

By W. W. COOKE.

The effect of this change has been noted at the Station each year for several years, and though the results are much the same each time, it seems advisable to give the figures for 1893, in order to increase the data already on record concerning this interesting subject. This is all the more necessary because, as has been frequently pointed out, the popular beliefs are erroneous in regard to the effect this change has on the quality of the milk.

Before going to pasture these cows were fed grain, hay and ensilage in abundance at the barn, and the feeding was continued in liberal allowance after the cows were turned out, the cows standing in the barn every night. The fact that under these conditions the cows increased somewhat in milk

flow, in quality of milk and in quantity of butter, shows how much better natural pasturage is than any artificial or dried food that can be given them at the barn.

The following table shows the changes that took place in the quantity and quality of the milk for the nineteen days, beginning ten days after they went to pasture, on May 5, as compared with the nineteen days just before they were turned out. The plus sign (+) indicates that their yield on pasture was greater than that at the barn, while the minus sign (—) indicates the opposite :

	Milk. lbs.	Fat. Per cent.	Fat. lbs.
Dinah.....	—18.9	+0.21	+0.3
Cigarette.....	+17.7	+0.38	+2.3
Minerva.....	—24.7	+0.04	—1.1
La Violette.....	+24.8	+0.24	+2.2
Floss.....	—32.5	+0.04	—1.5
Marguerite.....	+ 7.7	+0.12	+0.9
Bonnie.....	+98.2	+0.19	+4.7
Lottie.....	+18.2	+0.49	+2.0
Rena.....	+19.3	—0.04	+0.2
Bet.....	+157.0	—0.10	+5.9
Cloverette.....	+27.3	+0.47	+2.5
Beauty.....	+51.3	+0.49	+4.2
Creamer.....	+90.0	+0.00	+3.8
Gretchen.....	+39.6	+0.07	+2.3
Marburi.....	+43.3	+0.19	+2.7
	+589.4	+2.93	+34.0
	—76.1	—0.14	—2.6
Total.....	+513.5	+2.79	+31.4
Average.....	+34.2	+0.19	+2.1

The cows, as a whole, gained in everything, quantity of milk, quality of milk and quantity of butter fat. Out of the fifteen cows, twelve gain in quantity of milk, thirteen gain in quality and thirteen gain in quantity of fat. The total average gain is a little over a pound and a half of milk daily for each cow, or about one-twelfth of the whole yield; about a fifth of one per cent gain in the quality of the milk and a tenth of a pound of butterfat more daily, equivalent to one-seventh of the whole yield. In other words, the cows on pasture made as much butter in seven days as they had been yielding at the barn in eight days.

XII. THE PROPER TIME FOR HARVESTING FODDER CORN.

By J. L. HILLS.

The general subject of the composition of corn at its different stages of growth, and the proper time, therefore, for harvesting it, has been investigated at several stations in this country, including the Vermont Station.* The results of our tests on King Philip and B. and W. Ensilage corns made in 1889 were published in the 8d Report. A somewhat similar test was made on Sanford and Red Cob varieties during the summer of 1892, and forms the subject of the present article.

The corn was planted in hills, three feet apart each way, and made a good growth. On August 15th when the Sanford corn was tasselling and silking, and the Red Cob was showing no signs of tassels, a section of each, twenty by ten rows, was selected near the middle of large fields. Care was taken to choose portions where the growth was even.

Beginning on August 15th and continuing at intervals of two weeks, forty hills, equivalent to one-fifth of the plot, were cut from each section. The cuttings were successively made diagonally across the field, so that only every fifth hill in horizontal and perpendicular rows was taken at any one cutting, while continuous diagonal rows were taken at each cutting. In this way it is thought that any errors from possible unevenness of growth were avoided. Wherever missing hills or stunted growth occurred, the places were supplied by chance selection from outside the experimental section.

Immediately after each cutting the corn was taken to the barn, weighed, run through the cutter, sampled in quadruplicate, and reweighed in its cut condition as a check upon the first weight and to enable losses of moisture in cutting to be allowed for. The cut samples were dried at once in the drier,† after which fractional parts of each of the four samples were united for complete fodder analysis.

The dates and conditions of the corns at cutting were as follows:

August 13, Sanford, tasseling and silking.

Red Cob, not yet tasseled.

August 29, Sanford, well eared; ears in roasting stage.

Red Cob, beginning to tassel.

*New York (Cornell), Bulletin 4 and 16; New Hampshire, Bulletin 3; Pennsylvania, Bulletin 7; New York (Geneva), 8th Report, page 86; Illinois, Bulletin 20; Vermont, 8d Report, page 91.

†For method of drying, see 5th Vermont Station Report, foot note, page 76.

September 13, Sanford, beginning to glaze, nearly ready for silo.

Red Cob, tasseled and earing.

September 28, Sanford, glazed; being cut for silo.

Red Cob, partly eared; ears slightly glazed.

November 17, Red Cob, frosted and white.

Through a misunderstanding on the part of a field hand, the forty hills of Sanford corn left standing on September 28th were cut with the rest of the piece.

The analyses of the different cuttings with weights of the crop, dry matter and food ingredients per acre will be found in the following tables:

ANALYSES OF CORN CROP AT DIFFERENT STAGES OF GROWTH.

Date.	Sanford Corn.	Water.	Dry Matter.	ONE HUNDRED PARTS DRY MATTER CONTAIN						
				Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-Free Ex- tract and Fat.	Nitrogen.	Phosphoric Acid.	Potash.
Aug. 15	Tasseling and silking.	87.08	12.97	9.74	16.16	26.29	47.81	2.58	0.77	3.48
29	Well eared; roast stage	85.13	14.87	7.11	12.01	23.02	57.86	1.92	0.63	2.44
Sept. 13	Nearly ready for silo.	79.60	20.40	5.46	10.81	21.42	62.31	1.73	0.65	1.53
28	Glazed, being cut for silo	75.22	24.78	4.99	10.04	18.68	66.29	1.61	0.59	1.79
	Red Cob Corn.									
Aug. 15	Not yet tasseled.	89.66	10.34	12.43	16.19	26.00	45.88	2.59	0.69	5.07
29	Beginning to tassel.	88.58	11.42	9.89	12.00	28.78	49.35	1.90	0.55	3.61
Sept. 13	Tasseled and earing.	83.42	16.58	7.63	9.08	28.62	54.67	1.45	0.52	2.63
28	Partly eared, slightly glazed.	80.96	19.04	6.37	8.19	24.90	60.54	1.31	0.48	1.47
Nov. 17	Frosted and white.	68.68	31.32	7.06	8.61	26.55	57.78	1.38	0.35	1.39

**POUNDS OF DRY MATTER AND FOOD INGREDIENTS PER ACRE IN
CORN CROP AT DIFFERENT STAGES OF GROWTH.**

		Pounds of Green Fodder.	POUNDS OF								
			Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-Free Ex-tract and Fat.	Nitrogen.	Phosphoric Acid.	Potash.
Sanford.											
Aug.	15	19,475	16,949	2526	246.0	408.2	664.1	1207.7	65.2	19.4	87.9
	29	28,690	24,424	4266	303.3	512.3	982	2468.4	81.9	26.9	104.1
Sept.	13	29,440	23,434	6006	327.9	649.2	1286.5	3742.4	103.9	39.	91.9
	28	25,790	19,399	6391	318.9	641.7	1193.8	4236.6	102.9	37.7	114.4
Red Cob.											
Aug.	15	20,880	18,721	2159	268.4	349.5	561.3	979.8	55.9	14.9	109.5
	29	39,640	35,113	4527	447.7	543.2	1302.9	2233.2	86.0	24.9	163.0
Sept.	13	40,350	33,660	6690	510.4	607.5	1914.7	3657.4	97.0	34.8	175.9
	28	40,940	33,145	7795	496.5	633.4	1940.9	4719.2	102.1	37.4	114.6
Nov.	17	20,400	14,011	6389	451.1	550.1	1696.3	3691.5	88.2	22.4	88.8

It will be noticed that the per cents of dry matter and of nitrogen-free extract in the dry matter increase up to frost, while the per cents of ash, protein, fiber, nitrogen, phosphoric acid and potash in the dry matter decrease.

Owing to these facts, a hundred pounds of wet matter in the early stages of growth contains less food constituents than is contained later, while a hundred pounds of dry matter in the early stages of growth is richer than at any subsequent period. It is probable, however, that the protein has a greater nutritive value in the mature than in the unripe corn, and hence the lessened quality of the riper dry matter is partly compensated for.

The rapid increase in the gross weight of the crop and in the per cent of dry matter in it far overbalances any decrease in quality, and there is consequently an increase in weight of all the food and fertilizing ingredients of the corn crop up to the point of the glazing of the kernels.

The greatest gain in this experiment was made during the last two weeks of August and the first two weeks in September, between tasseling and slight glazing. During this time the Sanford corn gained 3480 pounds, or 138 per cent of dry matter, and the Red Cob, 4230, pounds, or 210 per cent of dry matter. During the next two weeks the nearly mature Sanford gained but 385 pounds of dry matter, only one-fifth as much as it did in the same time earlier. The still immature Red Cob, however, gained 1105 pounds of dry matter during the last two weeks of September; but this is

less than half its gain in the preceding two weeks. The gains in both varieties after the middle of September were almost entirely nitrogen-free extract matter, which is principally starch, sugar, etc.

The effect of severe frost is plainly seen in the case of the Red Cob hills, which stood in the field until the middle of November. There was more or less loss of every valuable food and fertilizing ingredient. This loss was probably larger than would have occurred had the corn been either stooked or ensilaged. The composition of the dry matter is not materially changed.

A comparison of the amounts of the various food ingredients in the two varieties at the time they were being cut for the silo (Sept. 28) will be of interest. The Sanford was practically mature, the kernels being well glazed, while the Red Cob was still immature, only partly eared and not many of the ears far enough along to glaze.

Representing the Sanford data by 100, we find the comparison to be as follows :

	Green Fodder.	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-Free Extract, Fat.	Nitrogen.	Phosphoric Acid.	Potash.
Sanford.....	100	100	100	100	100	100	100	100	100	100
Red Cob	159	171	122	156	99½	163	111	99	...	100

The Red Cob weighed 59 per cent more but only contained 22 per cent more of dry matter, which was mainly the less valuable portions of the ash and the woody fiber. It contained no more protein and but 11 per cent more starch, sugar, etc. As an offset to the gain in the carbohydrates is the necessity of handling three-fifths more of weight and nearly three-quarters more of water, and the fact that the crop was yet immature and but poorly eared at harvest. As an ensilage crop, however, the Red Cob cut at this stage was not inferior to the Sanford, and mixed with it made as good ensilage as we have ever had.

As stated in the outset, other Stations have published the results of experiments on this same subject. The data as to gross weight, dry matter and protein per acre at the various stages of growth given in these various experiments, are collated so far as may be in the following table. Some of the Stations tested several varieties, the results from which are averaged in the table to economize space. It may be well to say, however, that the general effect shown in the averages is also to be seen in individual cases. It will be noted that the data in the table are entirely in accord with that of the tests now under discussion. In all cases, also, where complete analyses of the crops from each cutting were made, the general results were in line with those of the present test.

RECORDS IN POUNDS PER ACRE OF THE CORN CROP CUT AT DIFFERENT STAGES OF GROWTH.

Station and Year.	Cornell (N. Y.)—1888.			Cornell (N. Y.)—1889.			New Hampshire—1888.			New Hampshire—1888.		
Varieties of Corn.	Pride of the North.			Pride of the North.			Southern.			Average 8 Varieties.		
Stage of Growth.	Green Fodder.	Dry Matter.	Protein.	Green Fodder.	Dry Matter.	Protein.	Green Fodder.	Dry Matter.	Protein.	Green Fodder.	Dry Matter.	Protein.
Nearly in bloom.....	18762	2000	251	24805	3658	361	32878	3536	497	12959	1378	213
Tasseled and silked....	.....	.....	.....	27830	3810	344	48875	7833	1098	30726	4070	561
Eared ; in milk.....	.....	.....	.....	30250	5274	467	41066	10102	969	36983	6050	648
Eared ; roasting stage	24578	4089	368	28980	5398	338	.....	.....	.....	29282	7741	770
Eared ; glazed.....	27674	7214	586	30108	9109	686	.....	.....	.....	.....	.....	.....
Mature.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Station and Year.	Pennsylvania—1889.			Geneva (N. Y.)—1889.			Vermont—1889 and 1891.			Vermont—1889 and 1891.		
Varieties of Corn.	Average 10 Varieties.			King Philip.			King Philip and Sanford.			B. and W. and Red Cob.		
Stage of Growth.	Green Fodder.	Dry Matter.	Protein.	Green Fodder.	Dry Matter.	Protein.	Green Fodder.	Dry Matter.	Protein.	Green Fodder.	Dry Matter.	Protein.
Nearly in bloom.	19302	2398	.....	18045	1619	240	.....	.....	.....	28288	8157	368
Tasseled and silked....	24285	3587	.....	25745	3078	437	20827	2897	357	36962	4451	446
Eared ; in milk.....	.....	.....	.....	32000	4643	479	26627	3808	379	38825	7247	520
Eared ; roasting stage.	28095	4804	.....	.....	.....	.....	28212	6181	522	46989	9583	669
Eared ; glazed.....	14097	6800	.....	32395	7202	644	24269	6437	587	.....	.....	.....
Mature.....	.....	.....	.....	28460	7918	678	.....	.....	.....	.....	.....	.....

It would seem from these data that the present experiment is typical and shows correctly the habit of growth of the corn plant. It has shed no new light upon the subject but has served to confirm former tests. The conclusions, suggested by the experiments of the other Stations as well as those made in Vermont, are that :

1. The corn plant increases its weight, weight of dry matter and value as it grows older, but

2. The nitrogen free extract matter increases so much faster than any other food ingredient that the dry matter decreases in quality as the plant grows older ; yet

3. The great increase in weight far overbalances any slight quality loss.

4. Green corn fodder usually weighs the most just as the kernel begins to glaze, but

5. It does not then contain as much dry matter as when fully glazed and mature, hence

6. Such varieties as will mature in Vermont latitudes should stand till ripened, while those which do not mature should stand as long as they are safe from frost.

7. The increase in dry matter after the kernel has begun to glaze is mainly nitrogen-free extract, hence

8. It may not always pay to run the risk of frosts for the sake of increased weight of starch and sugar, particularly if the crop is to be stooked. If intended for the silo the crop can be grown closer to the time of frosts without danger, and with increase in feeding value.

XIII. ENSILAGING SUGAR BEETS AND STRAW.

BY J. L. HILLS.

The last Report of this Station (page 88) contained an account of an experiment on ensilaging cut turnips, which failed because "there was too little dry matter, particularly of a fibrous nature, to hold together the mass." Similar experiments were tried with sugar beets this year, the only difference being that the fibrous matter was supplied by mixing more or less cut straw with the beets. The experiment was tried four times, there being one part of straw used in five, ten, fifteen and twenty parts of the whole. They all kept well and made a rather sour, but fairly good ensilage. The two containing the most straw were readily eaten, but those containing the least straw were not so well liked. The cows, however, were on good pasturage at the time the latter was given them.

The total losses in weight in the silos were $4\frac{1}{2}$ per cent. when the mass was one-fifth straw; $8\frac{1}{2}$ per cent. when the straw was one-tenth of the whole; $9\frac{1}{2}$ per cent. when it was one-fifteenth and 7 per cent. when it was one-twentieth. The first two lots remained in the silo about three weeks in the late spring. The last two were ensilaged in the summer and were kept in the silo two months. The tests were made in small experimental silos holding about three hundred pounds each.

XIV. FOUR WAYS OF PRESERVING FODDER CORN.

BY W. W. COOKE AND J. L. HILLS.

In the last Report of this Station there is detailed an experiment which was made to test the relative value of preserving fodder corn, in large stooks out doors or of putting it into the silo. The present test is a repetition of that on a more extended scale, and with some variations. There has been much complaint against the silo because the ears were put in with the stalks, and, of course, suffered some loss in the heating and fermenting that takes place in the silo. The objectors have said that by doing this there is a loss in the corn, which would be saved if the ears were picked off, husked and ground, and the corn fed to the cows in the shape of meal. A similar objection has been urged against the feeding of corn from the stooks, running the whole through the cutter and feeding corn and stalks together. It is believed by probably the majority of Vermont farmers that better returns would be obtained by picking off the ears, husking, grinding and then feeding the corn meal with the cut stalks. In order to get some reliable figures on this question the following experiment was planned and carried out.

When the corn was harvested at the Station farm in the fall of 1892, it was divided into four portions. Two rows were run through a cutter, cutting them into quarter-inch lengths, ears and all, and put into the silo. The next two rows had the ears picked off and then the stalks run through the same cutter into another silo. The next two rows were brought from the field and put in large stooks near the barn, and when wanted for feeding were run through the cutter, ears and all, being cut in the same length as the ensilage. The fourth two rows were brought to the barn and stooked in the same way, and then about a week before each stook was wanted for feeding it was brought into the barn, the ears picked off, husked, dried, ground, cob and all, the husks and stalks run through the cutter, and the meal fed with them. The ears that were picked off from the second set of rows put into the silo were left on the ground until they were partially

dried, then brought to the barn and husked, the husks being afterwards run through the cutter, and fed in connection with the ensilage from the stalks. The ears, cob and corn, were dried and ground, and the cob meal fed with the ensilage. Each eight rows through the field were treated in the same way, so that at the end the corn crop was divided into four equal parts. One part was all put in the silo. The second part had the stalks put into the silo, the ears ground and fed with the ensilage of the stalks. The third part was stooked and fed ears and all together from the stook. The fourth part was stooked, then the ears husked and ground, and the meal fed with the cut stalks.

The experiment was conducted with a herd of twelve cows. They were separated into four groups, and the four parts were fed, one to each group of three cows for four weeks. The cows were then shifted to another part, and then, at the end of four weeks again shifted and so on, until at the beginning of the fifth period, they were brought back to the same kind they had at the beginning, so that each group of cows ended as they had begun, and the difference in yield between the beginning and the end could be taken to represent the natural shrinkage that occurred during the five months.

Each cow was fed three pounds of wheat bran daily and two pounds of corn meal, given in two equal feeds morning and night. They were also fed ten pounds of very fine clover rowen in two equal feeds. The grain and the rowen were fed the first thing morning and evening, and after that had all been eaten up the cow was given all she would eat of the particular kind of corn fodder or ensilage she was receiving during that period. Thus all the orts belonged to the corn fodder or corn ensilage, as the case might be. The amount given to the cow was weighed, and the orts were weighed back daily. Nothing was fed the cows at noon, and they had water before them all the time.

The whole experiment went through very successfully. Not one of the cows was off her feed during the whole time. The two silos which received the ensilage part of the experiment were boarded over and covered deeply with other non-experimental corn, so that there was no loss at all on the top or around the sides of the experimental ensilage. The corn that was stooked out doors went through the winter very well indeed. The stooks were in an exposed place where the snow did not drift in deeply around them, none of them blew over, and the last that was fed, the latter part of March, was in excellent condition, all except the outer stalks being bright and green, with no sign of heating or moulding.

GROUPS OF COWS USED.

1.	2.	3.	4.
Beauty (Jersey) Rena Myrtle (Ayrshire) Mercedes (Holstein)	Marburi (Jersey) Bonnie (Grade) Cloverette (Holstein)	Lottie (Grade Jersey) Bet (Grade) Gretchen (Jersey Ayrshire)	Pansy (Grade Jersey) Creamer (Grade) Dorothy (Grade Jersey)

FEEDING PERIODS AND FODDERS FED EACH PERIOD TO EACH GROUP OF COWS.

Period Number.	Dates of Period.	Group 1. Fodder.	Group 2. Fodder.	Group 3. Fodder.	Group 4. Fodder.
I. II. III. IV. V.	Nov. 9-Dec. 7. Dec. 7-Jan. 4. Jan. 4-Feb. 1. Feb. 1-Mch. 1. Mch. 1-Mch. 29.	Whole Ensilage. Corn Stover. Stover Ensilage. Corn Fodder. Corn Fodder. Whole Ensilage.	Corn Stover. Stover Ensilage. Corn Fodder. Whole Ensilage. Corn Stover.	Stover Ensilage. Corn Fodder. Whole Ensilage. Corn Stover. Stover Ensilage.	Corn Fodder. Whole Ensilage. Corn Stover. Stover Ensilage. Corn Fodder.

Each lot of corn was weighed on the large scales as it was brought into the barn. While the corn was being put into the silo an armful was taken every little while, three or four to each load, at once weighed and put in a pile. At the end of the day, or at the farthest, at the end of the second day, these piles, which amounted to several hundred pounds, were removed, reweighed, run through the cutter, mixed thoroughly, weighed again and four samples of each taken for analysis. This was done for both the whole ensilage and the stover ensilage. The corn that was stooked was not weighed, since it was considered that it must necessarily have the same weight as the rows which were weighed that went into the silo. Everything, both ensilage and fodder, was weighed when fed, samples of the ensilage were taken once each week in triplicate, while samples in triplicate were taken of the corn fodder and stover every time a quantity was brought into the barn to be cut up. All meals and husks were sampled, so that there is a complete record of the composition of the various parts as harvested and as fed. Each milking was weighed. The first ten days of each period was considered preparatory, then the milk for the next six days was analyzed and also for the last six days of the period. The intervening six days' milk was considered to have the same composition as the average of the six days preceding and following, these eighteen days being taken as the experimental period. Records were kept, however, of all material fed and milk given during the ten days preparatory period, as well as the eighteen days experimental period.

The corn used in this experiment was taken from three different fields, and the records of each kept separately, so as to assist in checking the results and to prevent errors. The corn from each field was separated in the silos by boards, and stooked in different rows. As soon as one of the four parts from a field was all fed out, whatever remained of the other three parts was weighed and sampled and considered as surplus and fed to non-experimental cows. Thus all the cows were being fed all the time on corn from the same field.

The three fields together contained almost exactly six acres, and the total weight of the crop as harvested was 131,800 pounds, or an average per acre of 21,888 pounds, or nearly eleven tons. The crop was a mixture of Sanford and Red Cob corns, part of the field being planted to one and the rest to the other, the rows running north and south. The harvesting was done east and west so that each load contained both kinds, and by the time they had passed through the cutter, the silo or the stook, and reached the cows, they were very thoroughly mixed. The reason for planting in this way is that the Sanford corn has too large a proportion of ears to stalk, and if used alone the ensilage will contain so much corn that if the ordinary amount be fed daily to a cow it will be too rich and produce indigestion and a feverish condition of the system. On the other hand, the Red Cob corn, though

producing an enormous growth, yields but few ears in this latitude; but by mixing the Sanford and the Red Cob a large weight of crop is obtained with as much grain as is advisable to feed.

The parts of the fields used in this experiment were more largely Sanford than Red Cob. Of the whole weight, 88,623 pounds was Sanford, and 42,677 pounds, Red Cob. The Red Cob produced on the average 30,637 pounds, or about 15.3 tons per acre, and the Sanford, on the average 19,112 pounds, or about 9.6 tons per acre.

These averages of the whole crop give hardly a correct impression. The six acres mentioned above is the entire area planted to the three plots of corn, but one of these pieces was badly killed out by water standing on it, and another ran down into a large gully and was badly injured by washing.

The third piece, which was the largest, was not so much damaged and averaged 17.3 tons per acre of the Red Cob corn, and 12.1 tons per acre of the Sanford corn. Several square rods of the Red Cob, where it was not at all injured by the water, yielded over twenty tons per acre, and similar patches of the Sanford gave yields of over fifteen tons per acre.

DETAILS OF THE EXPERIMENT.

This experiment is the most extended ever undertaken at this Station. The feeding, sampling and analyzing occupied most of the time of five men for six months, and the calculations necessary in working up the data represent more than a thousand hours of steady figuring.

Some idea of the amount of labor involved can be obtained from the fact that the experiment necessitated

- 18,426 weights at barn,
- 439 samples of fodders,
- 1440 samples of milk,
- 124 complete analyses of fodders,
- 240 analyses of milk,
- 2290 single determinations of fodders,
- 1467 single determinations of milk.

It is obviously unwise to burden this report by printing any considerable portion of this immense mass of data. It would require much more than the entire space in this volume. It has seemed best not to publish any of the figures of the daily routine, but only the totals for the different fields and periods. But even in this very condensed form the bulk of figures is too great to be readily comprehended if printed with the discussion of the results and would deter the general reader from even a cursory examination. As, however, it does seem advisable that these records should be given somewhere, so that the real student of agricultural science can com-

pare them with the conclusions and with the results of similar experiments elsewhere, they have been inserted at the close of this article. All that is given with the discussion is the merest outlines of the summaries.

RELATIVE AMOUNTS OF DRY MATTER SAVED BY THE FOUR METHODS OF
TREATMENT.

Assuming for the present that the dry matter of the crop when preserved in each of these ways has equal feeding value, pound for pound, the amount of such dry matter saved as compared with the amount harvested will represent the efficiency of the method as a way of handling the corn crop.

Method of Handling the Crop.	Weight as Harvested.	Dry Matter in Crop as Harvested.	Dry Matter of Crop Saved Ready for Feeding.	Loss in Dry Matter.	Per cent of Loss in Dry Matter.
	lbs.	lbs.	lbs.	lbs.	%
Whole Ensilage*....	32,825	7,532	6,173	1,359	18
Stover Ensilage.....	32,825	7,532	5,978	1,554	21
Corn Fodder.....	32,825	7,532	6,169	1,363	18
Corn Stover.....	32,825	7,532	6,239	1,293	17
Total.....	131,300	30,128	24,559	5,569	
Average.....	32,825	7,532	6,140	1,392	18

It will be noticed that three of the methods give almost identical results. The slightly better showing of the corn stover over the corn fodder can be accounted for by its being brought into the barn from a week to ten days earlier each time for husking. The stover ensilage shows the largest losses. An examination of the records indicates that this increase of loss fell mostly on the ears and husks. These were picked off and left in the

*In all the discussion of this experiment, *whole ensilage* means the entire corn plant, ears and all, put into the silo. *Stover ensilage* means the part that had the ears picked off, the stalks put in the silo, the ears husked, dried and ground, and the cut husks and cob meal fed with the stalks when taken from the silo. *Corn fodder* means the portion that was stooked, then fed ears and all without husking, but after being run through the cutter. *Corn stover* means the portion, that was stooked, but, when brought into the barn for feeding, had the ears picked off, leaving the husks on the stalks, the ears were dried and ground and the resulting cob meal fed with the cut stalks.

field until some time after the rest of the crop was harvested, and were washed by several heavy rains before they were brought to the barn and husked. It is probable that had the weather been better so as to allow the ears and husks to dry out quickly, this method of preservation would have shown equally good results with the others. The stalks of the stover ensilage put into the silo, show 19 per cent of loss of dry matter as compared with 18 per cent of loss in the case of the whole ensilage.

These four methods of preserving the corn crop seem then to have about the same value *when each is used at its best*. It should be always borne in mind that the stooks of corn fodder at the Station were put up in the best possible manner. The corn was a large growth, the stooks large size, carefully and firmly put together and then the tops bound tightly so as to exclude rain and snow. It does not follow from the results of these tests that corn fodder bound loosely in small stooks, many of which are blown over, will keep with as little loss as the same corn would in a good silo. But it is a fair conclusion that it is possible by care to get better results from out door stooking than would be obtained from the same crops put in a careless way into a poor silo.

RESULTS OF FEEDING.

Each of the twelve cows was fed daily ten pounds of clover rowen and five pounds of grain consisting of three parts by weight of wheat bran and two of corn meal. In addition each cow had all it would eat of corn fodder or ensilage preserved in some one of the four ways. During the five months, each cow had one month of feeding on each of the four parts, and two months on one part, so that at the end an equal number of days' feedings had been used from each part and all equally distributed among the cows. In this way the individual variations of each cow were balanced and an equal chance given to each of the four methods of preservation. The amount used of each part was equivalent to the feed of one cow for 420 days, and the total yields are given in the following table for the last eighteen days of each period, equal to the product of one cow for 270 days :

Kind of Fodder.	Milk. lbs.	Total Solids. lbs.	Fat. lbs.	Solids not Fat. lbs.
Whole Ensilage*.....	4877	647	199	448
Stover Ensilage.....	4714	625	194	431
Corn Fodder.....	4724	632	197	435
Corn Stover.....	4860	648	199	449
Average.....	4794	638	197	441

*See preceding page for explanation of the use of these terms.

These results will probably be a surprise to many who would expect to see the ensilage surpass the stooked fodder, and a still greater surprise to the larger number who would expect decidedly better returns where the corn was husked and ground than where it was fed whole on the ear or put whole into the silo.

There is essentially the same return in milk and its products from the four methods of handling the corn crop. In milk yield the whole ensilage does the best and the stover ensilage the poorest, while the corn stover does just about as well as the whole ensilage and the corn fodder does but little better than the stover ensilage. The difference between the best and the poorest amounts to 3.3 per cent, or one-thirtieth of the total yield. The stover ensilage gives also the least butter yield, the difference between the highest and the lowest yields being 2.5 per cent, or one-fortieth of the whole.

Using the returns from the whole ensilage as the standard, the comparative yields from the others is given below :

Kind of Fodder.	Milk.	Total Solids.	Fat.	Solids not Fat.
Whole Ensilage	100	100	100	100
Stover Ensilage	97	97	97	97
Corn Fodder	97	98	99	98
Corn Stover	100	100	100	100
Average	98	99	99	99

It would be difficult to get any closer results if the cows had been fed without change of rations during the entire winter. Even these slight differences disappear if the average of the two ensilages is compared with that of the two stooked fodders. The same is true if the average of the two parts in which the ears were separated from the stalks and fed as meal is compared with the average of the parts in which the ears and stalks are fed together without grinding. The results may be fairly interpreted to mean that all four ways of handling the corn crop preserve it in good palatable condition, and if the cows are allowed to eat all they want they will give about the same returns during the same number of day's feeding from each method.

QUALITY OF THE MILK.

When similar comparisons have been made at this and at other Stations of corn ensilage and corn fodder, sometimes one has given the richer milk and sometimes the other. In the present instance the milk is very uniform in quality as is seen in the table that follows :

Kind of Fodder	Total Solids.	Fat.	Solids not Fat.
Whole Ensilage.....	13.27	4.09	9.18
Stover Ensilage.....	13.27	4.13	9.14
Corn Fodder.....	13.38	4.17	9.21
Corn Stover.....	13.33	4.09	9.24
Average.....	13.31	4.12	9.19

The four methods of handling the crop, therefore, produced no effect on the quality of the milk.

AMOUNT EATEN BY THE COWS.

This is the most important matter in the present experiment. It will be remembered that there was little difference in the amount of dry matter of the crop saved in the four ways of preserving it, and as just noted, the quantity and quality of the milk were quite uniform. But if the cows ate different amounts of the fodders to produce this equal quantity of milk, a corresponding difference would appear in the amount of milk and butter produced for each acre of crop handled in these different ways. Such is the case in the present tests. The cows were given all they wanted and it is fair to presume that they ate enough to satisfy the demands of the system. If the fodder was less digestible or nourishing they ate more of it, and when a less quantity of a different kind supplied their needs, they dropped off in the amount they took.

There was fed each day to each cow, 10 pounds of clover rowen, 3 pounds of wheat bran and 2 pounds of corn meal. The total amount fed was 10,800 pounds of clover rowen, 3240 pounds of bran, and 2160 pounds of meal, containing 13,900 pounds of dry matter, equally distributed among periods, cows and fodders. The table below shows total weight of dry matter eaten by the cows and the average daily amount of dry matter eaten by each cow:

Method of Preservation.	Total Dry Matter Eaten in the Entire Ration. lbs.	Average Amount of Dry Matter Eaten Daily per Cow. lbs.
Whole Ensilage.....	5948	22.03
Stover Ensilage.....	6411	23.75
Corn Fodder.....	6178	22.88
Corn Stover.....	6624	24.53

RELATIVE YIELDS FROM EQUAL AMOUNTS OF DRY MATTER IN THE ENTIRE RATION.

Combining the figures of this last table with the yields of milk and milk products already given, there can be calculated the amount produced by 100 pounds of dry matter when fed in the four different ways:

Method of Preservation.	YIELD PRODUCED FOR EACH 100 POUNDS OF DRY MATTER IN THE ENTIRE RATION.			
	Milk.	Total Solids.	Fat.	Solids Not Fat.
	lbs.	lbs.	lbs.	lbs.
Whole Ensilage.....	82.0	10.88	3.35	7.53
Stover Ensilage.....	73.5	9.75	3.03	6.72
Corn Fodder.....	76.5	10.23	3.19	7.04
Corn Stover.....	73.4	9.78	3.00	6.78

Since the amount of clover rowen and grain was the same for each cow in all the periods, it will give a clearer idea of the results of the experiment to leave this out of account for the present, and consider the amount of the fodder corn in its various forms that was eaten by the cows.

Method of Preservation.	Character of Material as fed.	Weight as Fed. lbs.	Dry Matter in one Day's Feed. lbs.
Whole Ensilage.....	Ensilage	43.1	9.16
	{ Ensilage	35.5 }	
Stover Ensilage.....	{ Cob Meal.....	3.9 }	10.88
	{ Husks.....	1.7 }	
Corn Fodder.....	Corn Fodder.....	21.9	10.01
Corn Stover.....	{ Stover and Husks.	17.5 }	11.66
	{ Cob Meal.....	4.0 }	

A large difference is apparent in the amount of dry matter eaten by the cows when the corn crop was fed to them in these different methods. Though producing equal quantities of milk, they ate much less of the whole ensilage to produce this milk than they did of any of the others. The greatest amount of food to produce the average yield was required when the cows were eating corn stover. Each of the ensilage lots makes a better showing than the corresponding stoked portion, and each case where the

grain is ground makes a poorer showing than its mate fed without husking or grinding.

For each 100 pounds of dry matter of the whole ensilage eaten, the cows ate 119 pounds of dry matter in the stover ensilage, 109 pounds from the corn fodder and 127 pounds of dry matter from the corn stover. The two ensilages required 110 pounds as compared with 118 pounds from the two stooked fodders; the portions where the corn was ground and fed as meal took 128 pounds as compared with but 105 pounds where no husking or grinding took place.

RELATIVE YIELDS FROM EQUAL AMOUNTS OF DRY MATTER.

The data already presented allow the calculation of the amount of milk and its products produced for each 100 pounds of dry matter fed in the various forms.

Method of Preservation.	Amount produced for each 100 pounds of Dry Matter eaten of the Experimental Fodder.			
	Milk.	Total Solids.	Fat.	Solids not Fat.
	lbs.	lbs.	lbs.	lbs.
Whole Ensilage.....	197	26.2	8.1	18.1
Stover Ensilage.....	161	21.3	6.7	14.6
Corn Fodder	175	23.4	7.3	16.1
Corn Stover.....	154	20.6	6.3	14.3

As it is evident that the whole ensilage produced the best results, the same thing can be expressed by considering 100 to represent the amount produced by the whole ensilage and comparing this with the amount yielded by the other fodders.

Method of Preservation.	Relative Amount produced for each 100 pounds of Dry Matter eaten of the Experimental Fodder.			
	Milk.	Total Solids.	Fat.	Solids not Fat.
Whole Ensilage	100	100	100	100
Stover Ensilage.....	82	81	83	81
Corn Fodder	89	89	90	88
Corn Stover.....	79	79	78	80

TOTAL YIELDS.

During the experimental periods *i. e.*, the last eighteen days of each feeding period, the cows ate certain portions of the total crop harvested and produced certain quantities of milk and butter. We have a right to assume that had the rest of the crop been eaten under similar conditions, it would have produced corresponding amounts of milk and butter. Uniting the three sets of results already given, there can be calculated the amount of milk and butter fat that would have been produced had all of the crop been fed under the conditions of the experimental periods.

Kind of Fodder.	Total Dry Matter Saved Ready for Feeding. lbs.	Dry Matter Fed During Experimental Periods. lbs.	CALCULATED YIELD OF THE WHOLE CROP.	
			Milk. lbs.	Fat. lbs.
Whole Ensilage.	6,173	2478	12,169	498
Stover Ensilage.	5,978	2986	9,598	396
Corn Fodder.....	6,169	2708	10,782	450
Corn Stover.....	6,239	3149	9,680	394

The comparison will show a little more plainly if the whole ensilage which did the best is taken as the standard and the others compared with it.

Kind of Fodder.	COMPARATIVE CALCULATED YIELD OF THE WHOLE CROP.	
	Milk.	Fat.
Whole Ensilage.....	100	100
Stover Ensilage.....	82	80
Corn Fodder.....	92	90
Corn Stover.....	82	80

WHICH FODDER LASTED THE LONGEST.

The method just employed in giving the comparative yields of the whole crop when treated in either of the four ways, is open to the objection that if the whole crop was fed to produce these yields, there would be fed with it different amounts of the rowen and the grain, and therefore the different parts would not be strictly comparable. The following method of comparison is not open to this objection, and gives in a practical form the relative value of these different ways of handling the corn crop:

It was noted in feeding the crops from the three fields that the corn stover gave out first each time, and that there was always more of the whole ensilage left than of either of the other portions. In other words, the whole ensilage lasted the longest. The product of milk and butter was just about the same for the same length of time from the four portions, so that the relative time the fodder lasted, becomes the best method of comparing these four ways of handling the corn crop. Each of the others will be compared with the whole ensilage since this lasted the longest.

If the corn stover had been fed until it was all eaten up and the whole ensilage had been fed the same number of days, the butter produced by the two feeds would have been exactly the same, but there would have been a great deal of the ensilage left, enough to have contained 1277 pounds of dry matter or 26 per cent of the entire amount of the dry matter in the ensilage. It is evident, then, that the whole ensilage has lasted so much longer than the corn stover, that the same results would be obtained by planting less land if the crop is to be fed as ensilage than would be required if the crop was to be handled as corn stover. In other words, 1.00 acre of corn made into whole ensilage yielded just as much return as 1.26 acres made into stover ensilage. Calculating in the same way for the other methods, it is found that an acre of whole ensilage is equivalent to 1.08 acres of corn fodder or 1.26 acres of stover ensilage.

The above is the comparison on the basis of the production of equal quantities of butter. If the comparison were made of equal products of milk, the relative advantage of the whole ensilage would be in each case slightly increased.

PRODUCT OF ONE ACRE.

The area harvested was almost exactly six acres, and there can therefore be readily calculated the amount of milk and its products that would be produced from one acre of the fodder corn preserved in the different ways.

Method of Preservation.	YIELD FROM ONE ACRE.				
	Milk.	Total Solids.	Fat.	Solids not Fat.	Equiva- lent of Butter.
	lbs.	lbs.	lbs.	lbs.	lbs.
Whole Ensilage	8113	1067	333	735	398
Stover Ensilage	6899	849	264	585	317
Corn Fodder	7188	961	300	661	360
Corn Stover	6420	856	263	593	316

The above represents the yield of the corn crop from one acre when it is fed under the conditions of the experiment and with its accompanying amount of hay and grain. But as this additional or non-experimental hay and grain would be in different quantities for the different methods, the figures do not represent a strict comparison of the results from the four methods. It would be strictly and exactly correct to say, that *the crop from one acre when preserved as whole ensilage and fed with 4313 pounds of clover rowen and 2157 pounds of grain, produced 8113 pounds of milk, 1067 pounds of total solids and 398 pounds of butter. It would take the yield from 1.26 acres preserved as stover ensilage or as corn stover, or the yield from 1.08 acres preserved as corn fodder with the same amount of hay and grain to produce an equal amount of milk and milk products.*

The gain in quantity of milk from whole ensilage over whole corn fodder, is nearly the same as was found in the extended experiment on the same point conducted by the Station two years ago and already reported.*

The gain in fat this time is somewhat greater than before, being 8 per cent as against 3 per cent two years ago.

Both the stover ensilage and the corn stover, show decidedly poor returns as compared with whole stooked fodder, and still more so when compared with whole ensilage. To explain this it will be necessary to consider more in detail the methods of handling the crop and the effects of these methods.

EFFECT OF DRYING AND GRINDING ON DIGESTIBILITY.

The difference in the method of handling the whole ensilage and the stover ensilage is that in one case the ears and husks were put in the silo, and in the other they were both dried, then the husks and ears separated, the latter still further dried by artificial heat until very dry, then ground and fed. There is no reason for believing that the stalks of the whole ensilage and the stover ensilage that were both put in equally good silos, kept any differently. It is fair to presume, and the analyses indicate, that they both lost the same amount of the same kind of feeding value. Whatever difference there is between the results is probably due to the different methods by which the husks and ears were handled. The record of the dry matter in the two silos is as follows.

*Ann. Rep. Vt. Exp. Sta. 1891, p. 84.

Kind of Fodder.	DRY MATTER.			
	Put in. lbs.	Taken out. lbs.	Loss. lbs.	Per cent of Loss.
Whole Ensilage.....	7,532	6,173	1,359	18
Stover Ensilage.....	4,817	3,882	935	19
Ears and husks of whole ensilage	2,715	2,291	424	15
Ears and husks of stover ensilage	2,715	2,096	619	23

In other words, the ears and husks put into the silo lost considerably less dry matter than did the ears and husks that were broken off, husked and dried. As before remarked, this may be due in large measure to the wet weather while the ears were lying in the field. But the husking, drying and grinding had other effects that were still less in its favor. The whole ensilage as fed had 63 per cent of its dry matter in the stalks and 37 per cent in the ears and husks; there were therefore fed the following amounts :

Kind of Fodder.	DRY MATTER EATEN IN		
	Stalks. lbs.	Ears and Husks. lbs.	Total. lbs.
Stover Ensilage.....	1790	1146	2936
Whole Ensilage.....	1558	915	2473
	232	231	463

The cows on the stover ensilage ate more dry matter from the stalks and more from the ears and husks than those on whole ensilage and yet gave even less milk. As there is no reason to believe that the stalks of the one ensilage were any different from those of the other, it follows logically that the dry matter in the ears and husks that had been dried and ground was of less value, i. e., *less digestible* than that in the ears and husks of the whole ensilage. This is the same as saying that the drying and grinding *decreased the digestibility* of the corn meal. It might be claimed that the exposure in the field was the cause of the loss in digestibility, did not the same thing appear just as strongly in the comparison of the corn fodder

with the corn stover. As fed out the ears of the corn fodder contained 32 per cent. of the dry matter and the stalks and husks 68 per cent.

Kind of Fodder.	DRY MATTER EATEN IN		
	Stalks and Husks	Ears.	Total.
	lbs.	lbs.	lbs.
Corn Stover.....	2185	1014	3149
Corn Fodder.....	1843	860	2703
	292	154	446

Here again the cows eating the corn stover and cob meal eat more dry matter of both the stalks and ears than those cows that were eating the corn fodder, and yield almost equal amounts of milk. Since it is probable that the stalks and husks in each case are nearly the same in feeding value, the difference would lie in the ears. These ears were stooked at the same time and stood side by side under the same conditions until just before they were fed, when those of the corn fodder were run through the cutter and fed, while those of the corn stover, after being run through the same cutter, were very thoroughly dried and ground. There seems to be no escape from the conclusion that this drying and grinding decreased very decidedly the digestibility.

RELATIVE COST OF THE FOUR METHODS.

As stated in the last Report, "the labor required in feeding was largely in favor of the ensilage. It took nearly as much time and expense to bring the corn fodder to the barn and stook it, as it did to run the corn through the cutter into the silo, but it took several times as much labor and expense to bring the corn from the stooks into the barn and cut and feed it as it did to take the ensilage out of the silo." If this is true as comparing whole ensilage with whole corn fodder, how much stronger is the comparison between whole ensilage and either of the methods in which the corn was husked and ground. Leaving out of account the bad effects of the drying and grinding, there is still a complete loss of all the labor and expense of the extra work. The usual charge in this State for husking is five cents a bushel and it takes two bushels of ears to make a bushel of meal. The charge for grinding is from an eighth to a tenth of the meal, so that if meal is worth \$20.00 a ton, the cost of husking and grinding will be 16 cents for each bushel of 56 pounds of cornmeal, without counting in the

labor or expense of carrying to mill. This is more than a quarter of the total value of the meal, and according to the results of these experiments is money and labor worse than wasted.

CHARACTER OF LOSSES.

In previous reports the character of the losses has been given that occur when corn is made into ensilage. In connection with the present experiment a comparison can be instituted between these losses and those that occur in the other methods of handling the crop.

Method of Preservation.	PERCENTAGE LOSSES FROM HARVESTING TO FEEDING.		
	Dry Matter.	Albuminoids.	Starch, Sugar, Etc.
Whole Ensilage..	18	11	27
Stover Ensilage..	21	14	29
Corn Fodder.....	18	9	27
Corn Stover.....	17	9	23
Average.....	18	11	24

The results show that notwithstanding the very different treatment given to the several portions, the losses are not only about the same in degree, but also much the same in kind.

RELATIVE LOSSES OF WATER AND DRY MATTER.

When grass is cut and quickly dried to hay it is customary to think of the process as a losing of nothing but water, all the solid matter of the grass being retained in the hay. If the grass is nearly ripe and the drying is quickly done, it is probable that not much loss of dry matter occurs. But from the experience in drying hay, there has come a tendency to consider that the same thing happens in the drying of corn fodder. Not many years ago it was thought that in the stooking of corn, the only change that occurred was the drying out of the water. The contrary has been shown so many times by the Experiment Stations that it can no longer be a matter of question, but there is still a general belief that after corn fodder has once dried out in the stook, it can be handled over, stacked outside the barn or put in a mow, and if it shows no signs of heating, no further loss of dry matter will occur.

The analyses made in connection with the previously described experiment, show that so long as corn fodder is exposed to the air it is constantly

losing weight. The further fact is also shown that *whenever there is loss of weight there is also loss of dry matter.*

There are at hand two sets of figures for stooked fodder, one refers to the first drying just after harvesting, and the other to losses in handling cured fodder.

A mass of stooked fodder weighed 4840 pounds when harvested, and contained 1171 pounds of dry matter. While standing in the stook it lost 2370 pounds in weight, of which only 104 pounds was dry matter. Only 5 per cent, then, of the total decrease in weight was dry matter. Another lot shrank 8312 pounds in weight, with a loss of but 683 pounds of dry matter, or 8 per cent.

A lot of dry corn fodder from the stook was brought to the barn, husked and the stalks spread out in a thin layer so that they would not heat. It weighed, then, 5890 pounds and contained 3072 pounds of dry matter. At the end of ten days, it weighed 5483 pounds and contained 2989 pounds of dry matter. Thus it had lost 407 pounds in gross weight and 83 pounds in dry matter; of the total loss in weight 20 per cent is dry matter. Another lot treated in the same way lost 292 pounds in weight of which 67 pounds was dry matter or 21 per cent. Still another lost 26 per cent. The average of the three lots shows that 22 per cent of the total loss of weight was loss of dry matter.

Two more lots were run through the cutter and lay for about a week on the barn floor in a layer a few inches deep. They showed no signs of heating, but lost weight continually, and analyses showed that of every 100 pounds of weight that was lost 28 pounds in one case and 34 pounds in the other, was dry matter.

It is fair to conclude from these results that all corn fodder when losing in weight is also losing in dry matter, and consequently in feeding value. The dryer the corn fodder is the larger is the proportion of this loss of weight that is dry matter.

The actual amount of feeding value that is thus lost after the dry corn fodder is brought into the barn, is a matter of surprise. In some cases the losses in ten days without any apparent heating were half as much as all that had been lost while standing in the stook most of the winter. These losses varied greatly with the temperature. During fall and spring they were large, and during the coldest weather of the middle of the winter they almost disappeared.

LOSSES OF WEIGHT AND DRY MATTER IN ENSILAGE.

In connection with the last subject may be mentioned the relation that exists between the losses of weight that occur in ensilaging fodder corn and the losses that occur at the same time in dry matter or feeding value. The tests now under consideration contain six lots of ensilage with full records bearing on this point.

Kind of Fodder.	Loss of Weight in Ensilaging. lbs.	Loss of Dry Matter in Ensilaging. lbs.	Dry Matter lost for each 100 pounds of loss in Weight. lbs.
Whole Ensilage.....	740	179	24
" ".....	2117	666	31
" ".....	2060	514	25
Stover Ensilage.....	642	175	27
" ".....	1678	395	23
" ".....	1614	366	22
Average.....	1475	382	25

All loss in both gross weight and dry matter. There are some variations but the average is 25 pounds of dry matter lost for each 100 pounds of decrease of weight in ensilaging. If, therefore, there are, for instance, 86 tons of fodder corn put into a silo and as fed out the ensilage weighs 70 tons (which would be about average figures), one can be reasonably sure that of these 16 tons loss in weight there has been one-fourth, or four tons of dry matter lost.

RELATION OF LOSS IN WEIGHT AND OF FEEDING VALUE IN ENSILAGE.

All writers on ensilage acknowledge a decided loss in weight of the fodder corn during the process of ensilaging. But there has been a tendency in agricultural papers to allow a high shrinkage in weight, usually 20 to 25 per cent, and still claim but small loss in feeding value. Our figures enable us to make a comparison between the two losses.

Kind of Fodder.	Percentage Loss of Weight in Ensilaging.	Percentage Loss of Dry Matter in Ensilaging.
Whole Ensilage.....	15.3	15.3
" ".....	15.4	21.0
" ".....	14.5	16.1
Stover Ensilage.....	18.0	21.3
" ".....	17.4	21.9
" ".....	14.1	16.6
Average.....	15.8	18.7

The losses are nearly even, but the special thing to be noted is that the loss in dry matter, and hence in feeding value, is *fully as large as the loss*

in weight. The average of eight experiments on the same subject in Wisconsin, gives 19 per cent as the loss of both weight and dry matter. Farmers should understand and remember then, that a loss of a quarter or a fifth in weight means an equal loss in feeding value.

RELATION OF LOSSES IN ENSILAGE TO RAPIDITY OF FEEDING.

The point brought out in the last paragraph, that the loss in feeding value is nearly proportional to the loss in weight, makes the following notes have a large practical value: The bottom layer of one of our silos contained as put in 2965 pounds of ensilage. It was uncovered April 22d and all fed out in 48 hours. It weighed as fed 2876 pounds, a shrinkage of 89 pounds or only 3 per cent. This shows that in the process of ensilaging the necessary losses are very small. The theory of the process would lead to the same conclusions. When the crop is put in the silo, much air goes in with it. In the process of ensilaging, the oxygen of this air unites with part of the crop to form carbonic acid gas. If the silo is perfectly tight around the sides and the ensilage is thoroughly covered so as to allow no air to work in from the top, the process will stop as soon as the original air is exhausted. But a very small part of the crop will be sufficient for this purpose, the amount given above, 3 per cent, being ample.

It is a fair conclusion from these theoretical and practical considerations, that in a well-made silo, the loss of feeding value in the crop is very small from the time it is put in the silo until the ordinary time of commencing to feed. That is, in all of the silo, except a foot or so of the top where the air from above can reach. It also follows that the large losses of feeding value which are found to have occurred when the silo is emptied, have taken place *at the time of feeding*. The upper surface of the ensilage is always exposed to the air and this air works down into the silo and acts on the upper few inches of the ensilage, all the time keeping ahead of the feeding. All of the ensilage as fed out has therefore been acted on by the air. It is this action *at the time of feeding*, which produces the large losses of a fifth to a quarter of the feeding value of the ensilage.

The practical question is, how can these losses be avoided. The answer is that they will be reduced just in proportion as the ensilage is fed out more rapidly.

The layer mentioned above was in a small silo seven feet square, and was 17½ inches deep, so that it was fed out at the rate of nearly 9 inches a day, and showed a loss of but 3 per cent in weight. A layer similar to this fed out at the same time at the rate of 1.7 inches daily showed a loss of 18 per cent in weight and consequently in feeding value. These tests were in the early part of April. Feeding from the same silos through the winter a depth of 168 inches in 168 days or exactly an inch a day, the average loss in

weight was 15 per cent. This shows that the changes do not go on so rapidly in cold weather as in warm.

If the surface through the winter had been lowered two inches a day instead of one, the loss in feeding value would have fallen undoubtedly below 10 per cent.

The further practical lesson can be drawn from these tests, that all silos built for summer feeding of ensilage should be deep and narrow. At less than two inches a day of lowering the surface, the ensilage is on the verge of spoiling before it is fed and the losses are very great. It is better to have a separate silo for summer feeding, or to put a partition through a large silo and feed from one part at a time. At three inches a day a mass of ensilage twenty feet deep will last from the first of July until the silo is filled again in September, and furnish that feed with but little loss and in the cheapest manner.

WEIGHT OF ENSILAGE PER CUBIC FOOT.

The report of the Wisconsin Station for 1891 contains a very instructive article by Prof. King on this subject. The thanks of all dairymen are due him for the mass of knowledge collected here in condensed and intelligible form. From the valuable tables given there we learn that on the average when a silo has been filled until the ensilage is 22 feet deep after settling two days, the mean weight of the ensilage will be 37 pounds per cubic foot. Under the same conditions the ensilage at the bottom will be compressed until it weighs 61 pounds to the cubic foot.

When the silos were filled at our Station in the fall of 1892, there was put into one of them 80,579 pounds of fodder corn. This filled the silo just 22 feet deep at the close of the day's work, but the filling had been done so slowly that the ensilage was already well settled. Four days afterwards 13,531 pounds more of corn was added which served to press the corn down to at least 21 feet deep. As the silo was seven feet wide and fifteen feet long at 21 feet deep, there would be an average weight of 36.5 pounds per cubic foot, which agrees very closely with Prof. King's 35.9 pounds per cubic foot. This would require then that the bottom foot should weigh at least 61 pounds, and probably a trifle more. At the bottom of this silo was a layer of ensilage of known weight, separated from the rest of the ensilage by a layer of boards. When this layer was reached, its thickness was measured before the boards were taken off, then the whole of it taken out and weighed. It had lost three per cent of its original weight, and weighed 38 pounds to the cubic foot. If there had been no loss in weight it would have weighed 40 pounds to the foot. Now the unanswered query is, why did it not weigh more? Was it never compressed to the calculated 60 pounds to the foot, or did it expand again as the ensilage above was fed off. So far as known, this point is not touched in any of the published writings on ensilage.

To make sure that this was not an exceptional case, the same thing was tested on three other lots of ensilage. In no case could a weight of more than 47 pounds per foot be found, where pressure enough had at some time been put upon it to reduce it to 60 pounds to the foot. When the silo was nearly emptied, the upper foot was found to weigh 34 pounds per cubic foot. Three feet below the surface it weighed 47 pounds to the foot, and no increase of bulk of this lower layer could be detected as this three feet of weight was removed, though it was equivalent to a pressure of more than a thousand pounds to the square yard.

CONCLUSIONS.

1. All four methods produced a good fodder, well preserved and relished by the cows.

2. The whole ensilage, the corn fodder and the corn stover saved about the same amount of dry matter ready for feeding; the stover ensilage saved three per cent. less than the other; the average of all was 82 per cent. saved, 18 per cent. lost.

3. There was no great difference in the amount of milk or butter produced by the different methods. The difference between the best, the whole ensilage, and the poorest, the stover ensilage, was about 3 per cent. The average of the two ensilages was the same as that of the two stooked fodders. The same is true of the average of the two stovers as compared with that of the two whole fodders.

4. The four methods of handling the crop produced no effect on the quality of the milk.

5. The cows ate very different quantities of dry matter when on the different portions to produce equal quantities of milk and butter.

6. For each 100 pounds of dry matter of the whole ensilage eaten, the cows ate 119 pounds of dry matter in the stover ensilage, 109 pounds from the corn fodder and 127 pounds of dry matter from the corn stover.

7. If all of each fodder had been fed out under the conditions of the experimental periods, with corresponding amounts of rowen and grain, the stover ensilage would have produced 82 pounds of milk for each 100 pounds produced by the whole ensilage. The corn fodder would have produced 92 pounds and the corn stover 82 pounds. The proportions are much the same with regard to the yield of butter.

8. One acre of the corn crop preserved as whole ensilage and fed with 4,313 pounds of clover rowen and 2,157 pounds of grain, produced 8,113 pounds of milk, 1,067 pounds of total solids and 898 pounds of butter.

9. The whole ensilage lasted the longest every time. Consequently it would take less of it to last a herd for a given time. One acre of corn made into whole ensilage yielded as much return in milk and butter as

1.26 acres made into stover ensilage or 1.08 acres made into corn fodder or 1.26 acres handled as corn stover.

10. The drying and grinding of the ears of the stover ensilage and corn stover seem to have made them less digestible, and this is the reason why these portions have done so much poorer than the whole ensilage.

11. Husking, shelling and grinding the corn to make a bushel of meal costs in this State 16 cents, or more than a quarter of the market value of the meal.

12. This labor and expense is more than wasted, since the cows did better on the whole corn than on the ground.

13. Dry corn fodder after being brought into the barn is still undergoing fermentation and loss even when no heating can be detected. In the course of ten days this loss may easily be half as much as took place in the stook. These changes and losses take place less rapidly in cold weather than in warm.

14. The losses of dry matter and feeding value in ensilage are closely proportional to the losses in weight.

15. The ensilage at the time of usual opening of the silo has in it still nearly all the feeding value that it had when put into the silo.

16. The large losses of feeding value that occur in the silo are almost entirely at the time of feeding out the ensilage.

17. These losses can be largely prevented by using small, deep silos that will allow the feeding of two to three inches from the surface daily.

18. This is especially true of ensilage to be used in place of a soiling crop in summer.

19. The ensilage in the lower portions of a silo is not so compressed and solid at the time of feeding as would be expected from its weight at the time the silo was filled.

RECORDS OF THE EXPERIMENT.

As noted in the early part of the discussion of this experiment, the original records are exceedingly voluminous. There is no attempt to give them here. The tables that follow are averages and totals for groups, fields, periods and fodders combined under the following heads :

- I. Average analyses of crop as harvested and as fed.
- II. Losses of Food Ingredients.
- III. Records of the Cows used in the Experiment.

I. AVERAGE ANALYSES OF CROP AS HARVESTED AND AS FED.

AVERAGE ANALYSES OF ENTIRE PLANT, AS HARVESTED AND WHEN
ENSILAGED OR STOOKED.

	Original Substance			Composition of Dry Matter.						
	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-Free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
<i>Field A.</i>										
As harvested.....	75.80	24.20	5.88	8.70	22.66	59.81	2.95	1.392	0.494	1.314
Whole Ensilage as fed.....	75.80	24.20	5.77	9.44	25.60	55.35	3.84	1.510	0.630	1.578
Stover Ensilage, husks and ears as fed.....	72.30	27.70	6.81	9.80	25.48	54.39	3.52	1.568	0.625	1.694
Corn Fodder as fed.....	55.25	44.75	7.44	9.79	28.73	51.55	2.49	1.566	0.598	1.422
Corn Stover and ears as fed.....	53.07	46.93	6.11	9.23	24.66	57.39	2.61	1.477	0.560	1.460
<i>Field B.</i>										
As harvested.....	76.91	23.09	5.42	8.96	19.34	63.21	3.07	1.434	0.488	1.683
Whole Ensilage as fed.....	78.43	21.57	6.76	9.54	24.35	55.50	3.85	1.527	0.625	1.905
Stover Ensilage, husks and ears as fed.....	73.52	26.48	6.80	9.46	23.92	56.32	3.50	1.514	0.596	1.990
Corn Fodder as fed.....	53.75	46.25	6.46	10.10	25.86	55.16	2.42	1.616	0.606	2.095
Corn Stover and ears as fed.....	42.47	57.53	6.10	9.98	24.40	56.80	2.72	1.597	0.620	2.043
<i>Field C.</i>										
As harvested.....	77.62	22.38	6.41	8.16	21.16	61.34	2.93	1.306	0.381	1.307
Whole Ensilage as fed.....	78.05	21.95	6.89	8.89	25.63	54.79	3.80	1.422	0.542	1.749
Stover Ensilage, husks and ears as fed.....	75.65	24.35	6.60	9.04	26.86	54.05	3.46	1.464	0.550	1.757
Corn Fodder as fed.....	51.43	48.57	6.72	8.90	25.28	56.51	2.59	1.424	0.489	1.450
Corn Stover and ears as fed.....	46.81	53.19	6.01	9.00	24.81	57.46	2.73	1.440	0.508	1.495
<i>Average.</i>										
As harvested.....	77.08	22.92	5.91	8.58	20.63	61.88	3.00	1.383	0.445	1.467
Whole Ensilage as fed.....	77.88	22.12	6.66	9.25	25.10	55.16	3.83	1.480	0.590	1.767
Stover Ensilage, husks and ears as fed.....	74.34	25.66	6.70	9.32	25.46	55.02	3.50	1.491	0.580	1.840
Corn Fodder as fed.....	52.97	47.03	6.73	9.50	26.05	55.21	2.51	1.520	0.551	1.689
Corn Stover and ears as fed.....	46.38	53.62	6.06	9.40	24.62	57.23	2.70	1.504	0.559	1.699

**AVERAGE ANALYSES OF CORN STOVERS AS HARVESTED AND WHEN ENSILAGED
OR STOOKED.**

	Original Substance		Composition of Dry Matter.							
	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-Free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid.	Potash.
<i>Field A.</i>										
Stover (without husks)										
as harvested.....	76.99	23.01	7.24	8.86	26.55	54.58	2.77	1.418	0.472	1.635
Stover Ensilage as fed....	77.92	22.08	7.86	9.62	30.46	48.70	3.36	1.539	0.622	1.991
<i>Field B.</i>										
Stover (without husks)										
as harvested.....	81.34	18.66	8.19	7.98	26.68	54.57	2.58	1.277	0.493	2.253
Stover Ensilage as fed....	82.36	17.64	9.86	9.56	32.18	45.73	3.17	1.530	0.607	2.888
<i>Field C.</i>										
Stover (without husks)										
as harvested.....	80.91	19.09	6.50	7.58	24.03	59.14	2.75	1.213	0.387	1.842
Stover Ensilage as fed....	81.52	18.48	8.20	8.61	32.86	47.06	3.27	1.378	0.497	2.131
<i>Average.</i>										
Stover (without husks)										
as harvested.....	80.52	19.48	7.27	7.95	25.45	56.63	2.70	1.272	0.442	1.960
Stover Ensilage as fed....	81.33	18.67	8.56	9.12	32.21	46.85	3.26	1.459	0.556	2.381
<i>Field A.</i>										
Stover (with husks) as										
harvested.....	76.46	23.54	7.22	8.62	26.71	54.62	2.83	1.379	0.475	1.669
Corn Stover as fed.....	50.19	40.81	7.19	8.88	29.92	51.86	2.15	1.421	0.523	1.695
<i>Field B.</i>										
Stover (with husks) as										
harvested.....	80.23	19.77	8.03	7.74	26.91	54.62	2.70	1.238	0.490	2.219
Corn Stover as fed.....	51.61	48.39	8.06	9.76	32.78	47.44	2.05	1.562	0.560	2.678
<i>Field C.</i>										
Stover (with husks) as										
harvested.....	80.31	19.69	6.53	7.50	24.32	58.85	2.80	1.200	0.390	1.852
Corn Stover as fed.....	55.41	44.59	7.82	8.68	32.48	48.92	2.10	1.389	0.442	1.887
<i>Average.</i>										
Stover (with husks) as										
harvested.....	79.71	20.29	7.22	7.78	25.74	56.49	2.77	1.245	0.443	1.962
Corn Stover as fed.....	54.82	45.18	7.80	9.08	32.15	48.89	2.08	1.453	0.499	2.145
<i>Husks.</i>										
Average, green.....	67.41	32.59	7.00	6.25	28.30	55.00	3.45	1.000	0.442	1.966
Field A, dry, as fed....	55.35	44.65	9.05	8.18	29.27	50.03	3.47	1.309	0.423	1.780
“ B, “ “ “.....	26.67	73.33	8.70	6.38	34.64	47.01	3.27	1.021	0.337	1.261
“ C, “ “ “.....	43.04	56.96	6.18	7.79	33.92	48.72	3.39	1.246	0.443	1.688
Average “ “ “.....	39.39	60.61	7.73	7.22	33.56	48.14	3.35	1.155	0.393	1.509

*All the figures under the headings "Ears and Husks as Harvested" and "Ears as Harvested" are based on the assumption that the difference between the weights and analyses of "whole ensilage" as put into the silo and of "stover ensilage" at the same time, represents the ears and husks. As this throws onto a small quantity all the errors of sampling and analysis of much larger quantities it is not strange that several discrepancies appear.

AVERAGE ANALYSES OF EARS AND HUSKS, EARS, CORMEAL, ETC.

	Original Substance		Composition of Dry Matter.							
	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-Free Extract.	Ether Extract.	Nitrogen.	Phosphoric Acid	Potash.
Field A.										
Ears and husks as harvested.....	72.46	27.54	2.70	8.81	13.53	72.09	3.37	1.830	0.564	0.571
Meal and husks as fed (Stov. Enslg.).....	24.98	75.07	4.20	10.19	13.20	68.57	3.84	1.680	0.635	0.960
Field B.										
Ears and Husks as harvested.....	66.48	33.52	1.80	10.25	9.73	74.52	3.72	1.640	0.481	0.939
Meal and husks as fed (Stov. Enslg.).....	17.05	82.95	3.25	9.34	12.47	70.98	3.96	1.494	0.579	0.736
Field C.										
Ears and husks as harvested.....	63.65	36.35	6.21	9.44	14.81	66.22	3.32	1.510	0.368	0.121
Meal and husks as fed (Stov. Enslg.).....	13.09	86.91	3.00	10.00	13.50	69.62	3.88	1.600	0.666	0.922
Average.										
Ears and husks as harvested.....	66.46	33.54	3.53	9.69	12.08	71.17	3.53	1.550	0.450	0.593
Meal and husks as fed (Stov. Enslg.).....	16.29	83.71	3.27	9.70	12.97	70.15	3.91	1.552	0.630	0.837
Field A.										
Ears as harvested*.....	77.27	22.73	1.35	8.96	8.92	77.04	3.37	1.434	0.562	0.112
Cob Meal (Stov. Enslg.).....	7.19	92.81	2.85	10.75	8.67	73.77	3.96	1.720	0.695	0.730
Cob Meal (Corn Stover).....	12.18	87.82	2.75	10.31	8.31	74.64	4.00	1.650	0.681	0.732
Field B.										
Ears as harvested.....	66.00	34.00	0.44	11.30	4.90	79.58	3.78	1.808	0.486	0.670
Cob Meal (Stov. Enslg.).....	9.58	90.42	2.10	9.97	7.79	76.05	4.09	1.595	0.631	0.626
Cob Meal (Corn Stover).....	6.27	93.73	2.22	10.61	7.95	75.19	4.03	1.693	0.738	0.797
Field C.										
Ears as harvested.....	63.46	36.54	6.05	10.05	12.10	68.41	3.31	1.610	0.361	?
Cob Meal (Stov. Enslg.).....	6.87	93.13	2.23	10.52	8.61	74.64	4.00	1.633	0.719	0.740
Cob Meal (Corn Stover).....	8.75	91.25	2.10	9.59	8.13	76.09	4.09	1.584	0.652	0.644
Average.										
Ears as harvested.....	66.22	33.78	2.70	10.52	8.15	75.06	3.57	1.683	0.445	?
Cob Meal (Stov. Enslg.).....	8.25	91.75	2.24	10.27	8.21	75.24	4.04	1.643	0.673	0.683
Cob Meal (Corn Stover).....	8.11	91.89	2.22	10.10	8.08	75.54	4.06	1.616	0.692	0.693

*See note at bottom of previous page.

II. LOSSES OF FOOD INGREDIENTS BY THE VARIOUS METHODS OF PRESERVATION.

	Whole Corn Ensilage.								
	Total Weight.	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-Free Extract.	Ether Extract.	Phosphoric Acid.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
<i>Field A.</i>									
As harvested.....	4840	3668.7	1171.3	68.9	101.9	265.4	700.5	34.6	5.8
Ensil'ge as fed.....	4100	3107.9	992.1	57.3	98.7	254.	549.1	38.	6.3
Losses from field to manger.....	740	560.8	179.2	11.6	8.2	11.4	151.4	+3.4	+0.5
Per cent of losses from field to manger.....	15.3	15.3	15.3	16.8	8.	4.3	21.6		
<i>Field B.</i>									
As harvested.....	18735	10564	3171.4	171.9	284.1	618.4	2005	97.4	15.5
Ensil'ge as fed.....	11618	9112.5	2505.5	169.4	239.3	609.9	1390	96.6	15.7
Losses from field to manger.....	2117	1451.1	665.9	2.5	44.8	3.5	614	0.8	+0.2
Per cent of losses from field to manger.....	15.4	13.7	21	1.5	15.8	0.6	30.6	0.8	
<i>Field C.</i>									
As harvested.....	14250	11061	3189.2	204.4	260.2	674.9	1956	93.4	12.2
Ensil'ge as fed.....	12190	9514.5	2675.5	184.3	237.8	685.6	1466	101.8	14.5
Losses from field to manger.....	2060	1546.3	513.7	20.1	22.4	+11	490	+8.4	+2.3
Per cent of losses from field to manger.....	14.5	13.9	16.1	9.8	8.6		25.1		
<i>Total.</i>									
As harvested.....	32825	25293	7532	445	646	1554	4661	226	33.5
Ensil'ge as fed.....	27908	21735	6173	411	571	1549	3405	237	36.4
Losses from field to manger.....	4917	3558	1359	34	75	5	1256	+11	+2.9
Per cent of losses from field to manger.....	14.9	14.	18.	7.6	11.6	0.3	26.9		

STOVER ENSILAGE AND HUSKS AND EARS.

	Total Weight.	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-Free Extract.	Ether Extract.	Phosphoric Acid.	Potash.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
<i>Field A.</i>										
As harvested....	4840	8668.7	1171.8	68.9	101.9	265.4	700.5	34.6	5.8	15.4
Ensilage, etc. as fed.....	3276.5	2368.7	907.8	61.8	88.8	231.3	494.	31.9	5.7	15.4
Losses from field to manger....	1563.5	1300	263.5	7.1	13.1	34.1	206.5	2.7	0.1	0.0
Per cent losses from field to manger.....	32.3	35.4	22.5	10.3	12.8	12.8	29.5	7.8	1.7	0.0
<i>Field B.</i>										
As harvested....	13735	10568.6	8171.4	171.9	284.1	613.4	2004.6	97.4	15.5	53.4
Ensilage, etc. as fed.....	9128	6710.6	2417.4	164.3	228.9	578.2	1361.4	84.6	14.4	48.1
Losses from field to manger....	4607	3853	754	7.6	55.2	35.2	643.2	12.8	1.1	5.3
Per cent losses from field to manger.....	33.5	36.5	23.8	4.4	19.4	5.7	32.1	13.1	7.1	9.9
<i>Field C.</i>										
As harvested....	14250	11060.8	8189.2	204.4	260.2	674.9	1956.3	93.4	12.2	41.7
Ensilage, etc. as fed.....	10896.4	8243.5	2652.9	174.8	239.8	712.5	1433.9	91.9	14.6	46.6
Losses from field to manger....	3353.6	2817.3	536.3	29.6	20.4	437.6	522.4	1.5	+2.4	+4.9
Per cent losses from field to manger.....	23.5	25.5	16.8	14.4	7.8		26.7	1.6		
<i>Total.</i>										
As harvested....	32825	25293	7532	445	646	1554	4661	226	33.5	110.5
Ensilage, etc. as fed.....	23301	17323	5978	401	558	1522	3289	208	34.7	110
Losses from field to manger....	9524	7970	1554	44	88	32	1372	18	+1.2	0.5
Per cent losses from field to manger.....	29.	31.5	20.6	9.9	13.6	2.5	29.4	8		0.5

STOVER ENSILAGE.

	Total Weight.	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-Free Ex- tract.	Ether Extract.	Phosphoric Acid,	Potash.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
<i>Field A.</i>										
As harvested.....	3570	2748.4	821.6	59.5	72.8	218.1	448.4	22.8	3.9	13.4
Ensilage as fed....	2928.2	2281.8	646.4	50.8	62.2	196.8	314.7	21.9	4.0	12.9
Losses from field to manger.....	641.8	466.6	175.2	8.7	10.6	21.3	133.7	0.9	+0.1	0.5
Per cent losses from field to manger..	18	17	21.3	14.6	14.5	9.8	29.8	4		4.1
<i>Field B.</i>										
As harvested.....	9640	7841.2	1798.8	147.3	143.4	479.9	981.8	46.4	8.9	40.5
Ensilage as fed....	7962.3	6558	1404.3	131.4	134.3	451.8	642.2	44.6	8.5	40.6
Losses from field to manger.....	1677.7	1283.2	394.5	15.9	9.1	28.1	339.6	1.8	0.4	+0.1
Per cent losses from field to manger..	17.4	16.4	21.9	10.8	6.3	5.9	34.6	3.9	4.5	
<i>Field C.</i>										
As harvested.....	11520	9323.1	2196.9	142.8	166.6	527.9	1299	60.4	8.5	40.5
Ensilage as fed....	9905.8	8074.6	1831.2	150.2	157.7	601.6	861.7	60.	9.1	39.
Losses from field to manger.....	1614.2	1248.5	365.7	+7.4	8.9	+74.	437.5	0.4	+0.6	1.5
Per cent losses from field to manger..	14.1	13.4	16.6		5.4		33.7	.7		3.7
<i>Total.</i>										
As harvested.....	24730	19913	4817.	350	383	1226	2728	130	21.3	94.4
Ensilage as fed....	20796	16914	3882	333	354	1250	1819	126	21.6	92.4
Losses from field to manger.....	3934	2999	935	17	29	+24.	909	4	+0.3	2
Per cent losses from field to manger..	15.9	15.1	19.4	4.9	7.6		33.3	3.1		2.1

EARS AND HUSKS OF STOVER ENSILAGE.

	Total Weight.	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-Free Extract.	Ether Extract.	Phosphoric Acid.	Potash.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
<i>Field A.</i>										
As harvested.....	1270	920.2	349.7	9.4	29.1	47.3	252.1	11.8	1.9	2
Meal and husks as fed.....	348.2	86.9	261.4	11.0	26.6	34.5	179.2	10.1	1.7	2.5
Losses from field to manger.....	921.7	833.4	88.3	+ 1.6	2.5	12.8	72.9	1.7	0.2	+ 0.5
Per cent. losses from field to manger.....	72.6	90.6	25.3		8.6	27.1	28.9	14.4	10.5	
<i>Field B.</i>										
As harvested.....	4095	2722.4	1372.6	24.6	140.7	183.5	1022.8	51	6.6	21.9
Meal and husks as fed.....	1165.7	152.6	1018.1	32.9	94.6	126.4	719.2	40	5.9	7.5
Losses from field to manger.....	2929.3	2569.8	359.5	+ 8.3	46.1	7.1	303.6	11	0.7	5.4
Per cent. losses from field to manger.....	71.5	9.4	26.2		32.8	5.3	29.6	21.6	10.6	41.9
<i>Field C.</i>										
As harvested.....	2730	1737.7	992.3	61.6	93.6	147	657.1	33	3.7	1.2
Meal and husks as fed.....	990.6	168.9	821.7	24.6	82.1	110.9	572.2	31.9	5.5	7.6
Losses from field to manger.....	1739.4	1568.8	170.6	37.	11.5	36.1	84.9	1.1	+ 1.8	+ 6.4
Per cent. losses from field to manger.....	63.7	90.3	17.2	60.1	12.3	24.6	12.9	3.3		
<i>Total.</i>										
As harvested.....	8095	5380	2715	96	263	328	1932	96	12.2	16.1
Meal and husks as fed.....	2505	409	2096	68	203	272	1471	82	13.1	17.6
Losses from field to manger.....	5590	4971	619	28	60	56	461	14	+ 0.9	+ 1.5
Per cent. losses from field to manger.....	69.1	92.4	22.8	29.2	22.8	17.1	23.8	14.6		

CORN FODDER.

	Total Weight.	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-Free Extract.	Ether Extract.	Phosphoric Acid.	Potash.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
<i>Field A.</i>										
As harvested...	4840	3668.7	1171.3	68.9	101.9	265.4	700.5	34.6	5.8	15.4
Fodder as fed...	2207	1219.3	987.7	73.5	96.7	233.8	509.2	24.5	5.9	14.
Losses from field to manger...	2633	2449.4	183.6	+4.6	5.2	+18.4	191.3	10.1	+0.1	1.4
Per cent losses from field to manger.....	54.4	66.8	15.7		5.1		27.3	29.2		9.1
<i>Field B.</i>										
As harvested...	13735	10563.6	3171.4	171.9	284.1	613.4	2004.6	97.4	15.5	53.4
Fodder as fed...	5066	2722.9	2343.1	151.4	236.6	606	1292.3	56.8	14.2	49.1
Losses from field to manger.....	8669	7840.7	828.3	20.5	47.5	7.4	712.3	40.6	1.3	4.3
Per cent losses from field to manger.....	63.1	74.2	26.1	11.9	16.7	1.2	35.5	41.7	8.4	8.1
<i>Field C.</i>										
As harvested...	14250	11060.8	3189.2	204.4	260.2	674.9	1956.3	93.4	12.2	41.7
Fodder as fed...	5844	3005.5	2838.5	190.7	252.8	717.5	1604.1	73.4	13.9	41.1
Losses from field to manger.....	8406	8055.3	350.7	13.7	7.4	+42.6	352.2	20	+1.7	0.6
Per cent losses from field to manger.....	59.1	72.8	10.9	6.7	2.8		18	21.4		1.4
<i>Total.</i>										
As harvested...	32825	25293	7532	445	646	1554	4661	226	33.5	110.5
Fodder as fed...	13117	6948	6169	416	586	1607	3406	155	34	104.2
Losses from field to manger.....	19708	18345	1363	29	60	+53	1255	71	+0.5	6.3
Per cent losses from field to manger.....	60.0	72.5	18.1	6.5	9.3		26.9	31.4		5.7

CORN STOVER AND EARS.*

	Total Weight.	Water.	Dry Matter.	Crude Ash.	Crude Protein.	Crude Fiber.	Nitrogen-Free Extract.	Ether Extract.	Phosphoric Acid.	Potash.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
<i>Field A.</i>										
As harvested...	4840	3068.7	1171.8	68.9	101.9	265.4	700.5	34.6	5.8	15.4
Stover, etc. as fed.....	2069.3	1098.1	971.2	59.3	89.6	239.4	557.5	25.4	5.4	14.2
Losses from field to manger.....	2770.7	2570.6	200.1	9.6	12.3	26.	148.	9.2	0.4	1.2
Per cent losses from field to manger.....	57.2	70.1	17.1	13.9	12.1	10.1	20.4	26.6	6.9	7.8
<i>Field B.</i>										
As harvested...	13735	10563.6	3171.4	171.9	284.1	613.4	2004.6	97.4	15.5	53.4
Stover, etc. as fed.....	4138.7	1757.6	2381.1	145.	238.	581.2	1352.3	64.6	14.8	48.7
Losses from field to manger.....	9596.3	8806	790.3	26.9	46.1	32.2	652.3	32.8	0.7	4.7
Per cent losses from field to manger.....	69.8	83.4	24.9	15.7	16.2	5.2	32.5	33.7	4.5	8.8
<i>Field C.</i>										
As harvested...	14250	11060.8	3189.2	204.4	260.2	674.9	1956.3	93.4	12.2	41.7
Stover, etc. as fed.....	5428.2	2541.2	2887.0	173.6	258.7	715.4	1660.6	78.7	14.7	43.2
Losses from field to manger.....	8821.8	8519.6	802.2	30.8	1.5	+40.5	295.7	14.7	+2.5	+1.5
Per cent losses from field to manger.....	61.9	77.0	9.5	15.1	0.6		15.1	15.7		
<i>Total.</i>										
As harvested...	32825	25293	7532	445	646	1554	4661	226	33.5	110.5
Stover, etc. as fed.....	11636	5397	6239	378	586	1536	3570	169	34.9	106.1
Losses from field to manger.....	21189	19896	1293	67	60	18	1091	57	+1.4	4.4
Per cent losses from field to manger.....	64.6	78.7	17.2	15.1	9.3	1.2	23.4	25.2		4.

* Since the ears were not picked off from the corn stover until after it was stockod and dried, it is not possible to give figures for the ears and stalks separately as *harvested*. Nor could it be assumed that the ears had the same weight and composition as the ears picked off the stover ensilage, owing to differences in husking in the field and at the barn.

III. RECORDS OF THE COWS INDIVIDUALLY AND BY GROUPS DURING THE EXPERIMENT.

Cow and Group.	Number of Period.	Experimental Fodder.	Preliminary Period.		Experimental Period.								To 100 pounds of Dry Matter in experimental fodders, there were given		
			Dry Matter Eaten.	Milk Given.	Dry Matter Eaten.	Milk Given.	Total Solids.	Fat.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.		
			lbs.	lbs.	lbs.	lbs.	%	%	lbs.	lbs.	lbs.	lbs.	lbs.		
Beauty (1)	I	W. E. *	63.7	130.9	131.8	245.6	15.25	5.38	37.45	13.21	186.4	28.4	10.0		
	II	C. S.	112.1	143.3	208.6	244.6	15.27	5.35	37.35	13.09	177.2	17.9	6.3		
	III	S. E.	95.6	134.7	127.5	220.6	15.65	5.74	34.52	12.66	173	27.1	10.0		
	IV	C. F.	101.3	123.1	127.7	184.7	15.68	5.79	28.96	10.69	144.7	22.7	8.3		
	V	W. E.	70.8	115.3	130.3	212.5	15.42	5.57	32.77	11.84	163.1	25.2	9.1		
Rena Myrtle. (1)	I	W. E.	106.6	341.8	213.6	645.4	12.09	3.39	78.03	21.88	302.2	36.5	10.2		
	II	C. S.	159.9	366.5	282.9	661.7	12.09	3.34	80.00	22.10	233.9	28.3	7.8		
	III	S. E.	127.8	343.9	194.4	561	12.37	3.55	69.40	19.92	288.5	35.7	10.3		
	IV	C. F.	158.6	303.1	204.1	489	12.15	3.49	59.40	17.06	239.6	29.1	8.4		
	V	W. E.	102.9	288.5	177.2	502.8	12.31	3.48	61.90	17.50	283.7	34.9	9.9		
Mercedes (1)	I	W. E.	96.4	177.4	193.9	319.2	12.60	3.50	40.22	11.17	164.8	20.8	5.8		
	II	C. S.	136.9	174	219.1	289.9	13.06	3.79	37.86	10.99	132.3	17.3	5.		
	III	S. E.	114.3	148.9	165.9	218.4	13.68	4.32	29.88	9.43	131.7	18.	5.7		
	IV	C. F.	156.9	131.1	197.6	181	14.10	4.95	25.52	8.60	91.6	12.9	4.3		
	V	W. E.	86.4	89.8	133.9	109.1	15.29	5.17	16.68	5.64	81.5	12.4	4.2		
Marburi (2)	I	C. S.	89.3	140	167.2	257.1	14.57	4.96	37.46	12.75	153.8	22.4	7.6		
	II	S. E.	78.5	135.9	204.6	243.9	14.62	4.95	35.66	12.07	119.2	17.4	5.9		
	III	C. F.	74.3	136.1	149.7	249.2	14.94	5.10	37.23	12.70	166.4	24.9	8.5		
	IV	W. E.	83.6	134.8	128.8	198.4	15.02	5.17	29.80	10.26	154.8	23.1	8.		
	V	C. S.	66.8	122.8	103.6	221.4	15.00	5.24	33.21	11.60	213.6	32.	11.2		
Bonnie (2)	I	C. S.	122.9	232.2	271.9	458.4	12.76	3.51	58.49	16.09	168.6	21.5	5.9		
	II	S. E.	105.3	249.2	275	453.4	12.79	3.72	57.99	16.37	164.9	21.1	6.1		
	III	C. F.	121.0	252.7	239.1	457.6	13.12	3.73	60.04	17.07	191.4	25.1	7.1		
	IV	W. E.	98.8	252.7	161.7	398.9	13.19	3.94	52.62	15.72	246.8	32.5	9.7		
	V	C. S.	116.3	216.5	201.2	400.6	13.30	4.00	53.28	16.02	199.1	26.5	8.		
Cloverette (2)	I	C. S.	79.8	162.8	174.5	299.6	12.33	3.34	36.94	10.01	171.7	21.2	5.7		
	II	S. E.	88.2	164.4	217.0	310.8	12.21	3.21	37.95	9.98	143.2	17.5	4.6		
	III	C. F.	114.9	172.2	231.6	299.1	12.44	3.18	37.21	9.51	129.2	16.1	4.1		
	IV	W. E.	98.9	169.5	148.2	246.2	12.60	3.47	31.02	8.54	166.2	21.	5.8		
	V	C. S.	107.8	144.7	188.5	271.8	12.84	3.58	34.90	9.73	144.2	18.5	5.2		

*W. E. means Whole Ensilage; C. S. Corn Stover; S. E. Stover Ensilage; and C. F. Corn Fodder.

Cow and Group.	Number of Period.	Experimental Fodder.	Preliminary Period.		Experimental Period.								To 100 pounds of dry matter in experimental fodder there were given		
			Dry Matter Eaten.	Milk Given.	Dry Matter Eaten.	Milk Given.	Total Solids.	Fat.	Total Solids.	Fat.					
											lbs.	lbs.			
			lbs.	lbs.	lbs.	lbs.	%	%	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Lottie (3)	I	S. E.	109.3	230.1	215.5	897.3	12.28	3.71	48.79	14.74	184.4	22.7	6.8		
	II	C. F.	145.5	215.6	219.8	290.8	12.82	4.13	37.28	12.01	132.3	17	5.5		
	III	W. E.	93.2	156	180.8	231.6	12.93	4.06	36.41	11.43	155.8	20.1	6.3		
	IV	C. S.	118.6	142.1	195.2	190.1	13.44	4.49	25.55	8.54	97.4	13.1	4.4		
	V	S. E.	98.5	124.5	161.1	229.7	13.55	4.43	31.12	10.18	142.6	19.3	6.3		
Bet (3)	I	S. E.	113.9	214.4	214.3	882.4	12.13	3.32	46.39	12.70	178.4	21.7	6		
	II	C. F.	145.2	219.9	228.0	889.1	12.41	3.44	48.29	13.39	170.7	21.2	5.9		
	III	W. E.	103.8	214.5	217.4	839.6	12.74	3.64	49.64	14.18	179.2	22.9	6.5		
	IV	C. S.	139.9	210.9	239.8	838.9	12.78	3.78	43.31	12.81	141.3	18.1	5.3		
	V	S. E.	110.9	177.1	189.2	844.9	12.76	3.68	44.01	12.69	182.3	23.3	6.7		
Gretchen (3)	I	S. E.	95.5	158.1	173.9	300.9	13.96	4.49	42.01	13.51	173	24.2	7.8		
	II	C. F.	94.1	154.9	148.0	263.5	14.55	4.93	38.34	12.99	178	25.9	8.8		
	III	W. E.	81.2	133.8	182.9	256.3	14.82	5.08	37.98	13.02	140.1	20.8	7.1		
	IV	C. S.	122.4	139.1	206.7	211.8	15.52	5.71	32.87	12.09	102.5	15.9	5.8		
	V	S. E.	89.2	124.3	149.7	223	15.12	5.36	33.72	11.95	149	22.6	8		
Pansy (4)	I	C. F.	66.7	86.6	158.5	160.8	14.13	4.58	22.72	7.36	101.5	14.3	4.6		
	II	W. E.	62.2	87.7	122.3	157.6	13.95	4.32	21.99	6.81	128.3	17.9	5.5		
	III	C. S.	127.5	83.9	217.7	143.8	14.27	4.44	20.52	6.38	66.1	9.4	2.9		
	IV	S. E.	108.9	75.3	203.4	110.1	15.30	5.38	16.85	5.92	54.1	8.3	2.9		
	V	C. F.	66.6	70.4	110	122.5	14.69	4.88	18.00	5.98	111.4	16.4	5.4		
Creamer (4)	I	C. F.	145.2	318.4	270.7	598.3	12.56	3.69	75.15	22.08	221	27.8	8.2		
	II	W. E.	112.5	335.7	203.3	595.8	12.82	3.88	76.38	23.12	293.1	37.6	11.4		
	III	C. S.	158.6	333.8	257.8	581.5	12.95	3.89	75.30	22.62	225.5	29.2	8.8		
	IV	S. E.	127.1	321.1	231.6	508.9	13.19	4.16	67.13	21.17	219.8	29	8.1		
	V	C. F.	108.6	288.5	157.4	496.7	13.25	4.20	65.81	20.86	315.6	41.8	13.3		
Dorothy (4)	I	C. F.	89.2	200	151.9	320	14.40	4.79	46.08	15.33	210.7	30.3	10.1		
	II	W. E.	82.4	199.1	146.3	318.3	13.93	4.76	44.50	15.15	217.6	30.4	10.4		
	III	C. S.	116.9	186	214.3	289.7	14.18	4.83	41.08	13.99	135.2	19.2	6.5		
	IV	S. E.	110.4	152.1	213.2	208.8	14.33	5.12	29.92	10.69	98	14	5		
	V	C. F.	63.6	113.2	108.7	221.9	14.39	5.15	31.93	11.43	204.1	29.3	10.5		

Number of Period.	Experimental Fodder.	Preliminary Period.		Experimental Period.								To 100 pounds of Dry Matter in experimental fodder, there were given.			
		Dry Matter Eaten.	Milk Given.	Dry Matter Eaten.	Milk Given.	Total Solids.	Fat.	Total Solids.	Fat.	Milk.	Total Solids.	Fat.			
		lbs.	lbs.	lbs.	lbs.	%	%	lbs.	lbs.	lbs.	lbs.	lbs.			

Group One—Beauty, Rena Myrtle, Mercedes.

I	W. E.	266.7	650.1	539.3	1210.2	12.87	3.82	155.70	46.26	224.4	28.9	8.6		
II	C. S.	408.9	683.8	710.6	1196.2	12.98	3.86	155.21	46.18	168.3	21.8	6.5		
III	S. E.	337.7	627.5	487.8	1000	13.38	4.20	133.80	42.01	205	27.4	8.6		
IV	C. F.	416.8	557.3	529.4	854.7	13.32	4.25	118.88	36.35	161.4	21.5	6.9		
V	W. E.	260.1	493.6	441.4	824.4	13.51	4.24	111.35	34.98	186.8	25.2	7.9		

Group Two—Marburi, Bonnie, Cloverette.

I	C. S.	292.	535	613.6	1015.1	13.09	3.83	132.89	38.85	165.4	21.7	6.3		
II	S. E.	272.	549.5	696.6	1008.1	13.05	3.86	131.60	38.92	144.7	18.9	5.6		
III	C. F.	310.2	561	620.4	1005.9	13.37	3.90	134.48	39.28	162.1	21.7	6.3		
IV	W. E.	281.3	557	438.7	843.5	13.45	4.09	113.44	34.52	192.3	25.9	7.9		
V	C. S.	290.9	484	493.3	893.8	13.58	4.18	121.39	37.35	181.2	24.6	7.6		

Group Three—Lottie, Bet, Gretchen.

I	S. E.	318.7	602.6	603.7	1080.6	12.70	3.79	137.19	40.95	179.	22.7	6.8		
II	C. F.	388.8	590.4	595.8	943.4	13.13	4.07	123.91	38.39	158.4	20.8	6.9		
III	W. E.	278.2	504.3	581.1	927.5	13.37	4.17	124.03	38.63	159.6	21.4	6.6		
IV	C. S.	380.9	492.1	641.7	740.8	13.73	4.51	101.73	33.44	115.4	15.9	5.2		
V	S. E.	298.6	425.9	500	797.6	13.65	4.37	108.85	34.82	159.5	21.8	7.		

Group Four—Pansy, Creamer, Dorothy.

I	C. F.	301.1	605	581.1	1079.1	13.34	4.15	143.95	44.77	185.7	24.8	7.7		
II	W. E.	257.1	622.5	472.4	1071.7	13.33	4.21	142.37	45.08	227.4	30.2	9.5		
III	C. S.	403	603.7	689.8	1015.	13.49	4.24	136.9	42.99	147.1	19.8	6.2		
IV	S. E.	346.4	548.5	648.2	827.8	13.76	4.56	113.9	37.78	127.7	17.6	5.8		
V	C. F.	238.8	472.1	376.1	841.1	13.76	4.55	115.74	38.27	223.7	30.8	10.2		

Totals of all Periods for Each Group.

Group	1	1690	3012	2708	5085	13.17	4.05	669.9	205.8	187.8	24.7	7.6		
"	2	1446	2687	2863	4766	13.30	3.97	633.8	188.9	166.4	22.1	6.6		
"	3	1661	2615	2922	4490	13.27	4.15	595.7	186.3	153.7	20.4	6.4		
"	4	1546	2847	2768	4835	13.52	4.32	653.4	208.9	174.7	23.6	7.6		

THE ACCURACY OF WEATHER PREDICTIONS.

By J. L. HILLS.

The weather forecasts during the crop growing season are daily telegraphed to the Experiment Station from the Signal Service office in Boston.

The flags are displayed from the east end of the Station barn, and can be seen for many miles to the North, East and South. The messages are received at noon and predict the weather for the following day. During the night a second telegram is sent to the daily papers, again forecasting the weather for the next day.

During the months of June and July, '98, a record of the character of the weather at Burlington was kept to compare with the predictions. The results may be summed up as follows:

The first telegrams accurately foretold the weather in the proportion of 73 times in 100 (i. e., 73 per cent.) and the temperature changes, 65 per cent., while the second dispatches foretold weather aright 72 per cent., temperature changes 61 per cent. and wind direction 85 per cent. of the time. It may be said, then, roughly that seven times in ten the weather was correctly foretold, six times in ten the changes in temperature and nine times in ten, the direction of the wind.

When no change in the weather was predicted, the forecasts were correct 74 per cent of the time, and when a change in the weather was prophesied, this change took place only 37 per cent of the time. In other words, if the signals foretold that to-morrow was going to be like to-day, the chances were three to one the signals were right. But if they prophesied that to-morrow was to be different from to-day, the chances were two to one that their prophesying would turn out incorrect.

During these two months the earlier messages predicted fourteen rainy days, showers, thunderstorms, etc., seven (50 per cent.) of which occurred, while the later wires foretold twenty-one rains, showers, etc., of which twelve (57 per cent.) occurred. There were eleven days when unpredicted rains fell. Three of these were the hardest storms of the season. These make the percentage of success in rain predictions but 38 per cent.

There were eighteen changes in the average temperature of 5° or more. Nine (50 per cent.) were correctly foretold, in five cases the change was opposite to that predicted, while in four cases of about 7° change, no change was foretold. The very cool and stormy weather of July 22 to 26 was not

predicted. In general it may be said that the forecasts during unchanging weather were quite accurate, but that changes were much less correctly predicted.

It seems probable that the geographical situation of Burlington, in a valley between the Green Mountains and the Adirondacks and beside a lake over a hundred miles long, has something to do with the percentages of success and failure of weather predictions in this locality. It is a well known fact that storms follow water courses, and that hilly countries are peculiarly liable to weather changes. Hence this article should not be considered a criticism of the ability of the forecast official, but a contribution to the study of the efficiency of the forecast system in a mountainous country.



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